YOUR CONSTRUCTION AND OPERATING QRP SOURCEBOOK

QRP Quarterly

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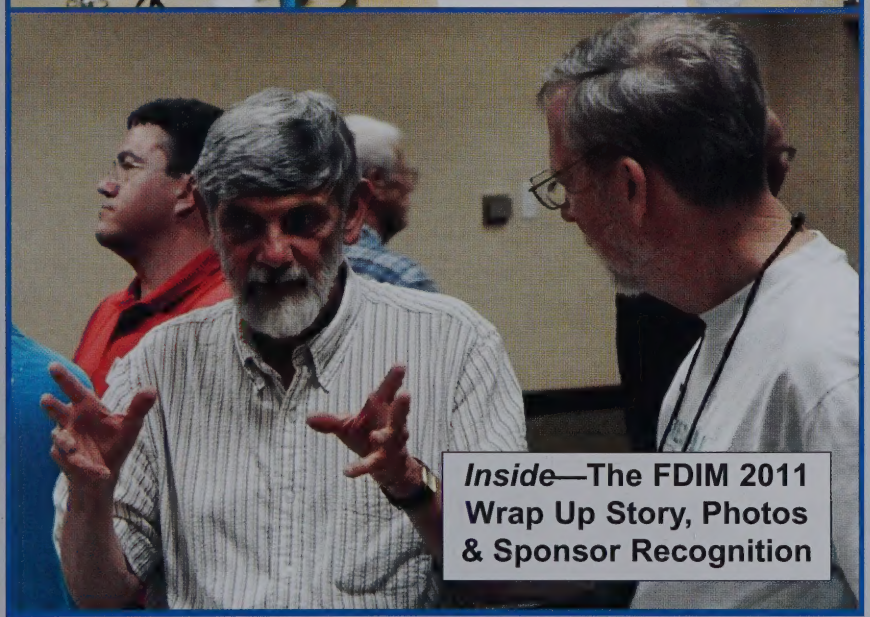

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- QRP Clubhouse—VE3-Land Build-a-Thon & Ozarkcon
- N7ZWY's RX Preselector and Antenna Tuner
- N6QW Describes a Pocket Size 20M SSB XCVR
- Contest Results—
  2011 Grid Square Sprint
  2011 ARCI Spring QSO Party

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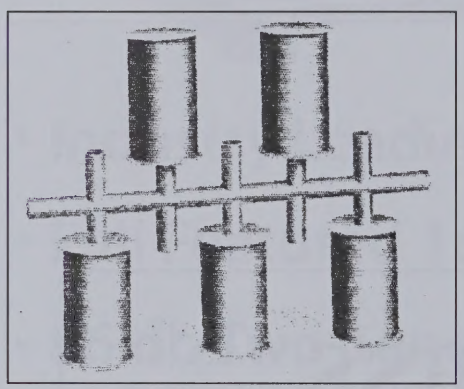

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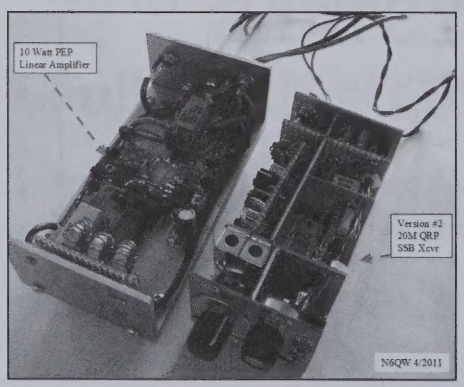

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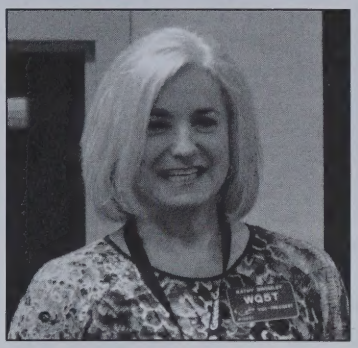

I must say of the nine Four Days in May I have attended, the 2011 FDIM celebrating QRP ARCI's 50th anniversary was one of the best. It was of course not without a few "hiccups," but I feel those hiccups are opportunities for us to make next year even better. Everyone who works with QRP ARCI and FDIM are all volunteers who are appreciated more than they will ever know. The chairman of the FDIM committee, those helping with registration, selling bus passes and raffle tickets, mentors helping with the build-a-thon, are only a few of the volunteers you see who donate their time and energy to make FDIM the best it can be. There are also those who are behind the scenes, making certificates, helping with the prizes either by getting donations or just carrying the prizes or computers and printers from one room to the other. They are FDIM attendees giving of themselves to make FDIM enjoyable for everyone. It really makes me proud to be part of a club where members are anxious to help.

It was great walking into the hotel lobby on Wednesday afternoon and seeing so many familiar faces from years past. Thursday started with hams all gathered around tables in the dining room chit chatting over a breakfast buffet and then hurrying to get their seat in the seminar room. We had over 200 hams and guest eagerly waiting for the seminars to start. After a brief welcome and a show of hands for the first timers for FDIM of which we had about 50%, our first speaker David Cripe, NMØS, started the day with "The Plumbing Defined Radio" which was followed by "Back to the Future" presented by the tag team of Jay Slough, K4ZLE and Jim Everly, K8IKE. After the coffee break we saw a short video by Diana Eng, who was also attending FDIM, and then we were honored to have Roy Lewallen, W7EL, introduce the Reverend George Dobbs, G3RJV, who spoke on the topic "In my Workshop—Some Ramblings of a (retired) Vicar with a Soldering Iron." I can't think of anyone who ever tires of listening to the "ramblings" of the Reverend Dobbs.

After lunch the afternoon was off to a great start with Nobel Prize laureate, Joe Taylor, K1JT, who spoke about the "Advances in Weak Signal Communications." Ward Harriman, AE6TY, followed Joe, with an "Introduction to Digital Signal Processing (without the math)." We finished the day of seminars with Chris Howard, WA4YG, who at 15 years of age gave an inspiring talk about "QRP Kit Building for Youth."

If you were unable to attend the seminars, you can purchase a copy of the *Conference Proceedings* through the Toy Store, check it out online at www.qrparci.org.

After the seminars, there were still activities such as the Build-a-thon, Meet and Greet the Speakers, and a room full of vendors showing the latest and greatest in QRP and Ham Radio, which I will let someone else expound upon. Don't forget we also had K6JSS set up making as many contacts as possible. That is a lot for the first day, we still had three more days that included vendors, home brew contest and the banquet.

I will finish up by saying if you were not at the 2011 FDIM, you really missed a great time. It was fun watching everyone after a long day of activities sit around tables exchanging old and new stories with an old friend or maybe a new one, one whom we have only spoken to over the air but now have a face to go with that call sign. Hopefully next year yours will be the face I see.

—72 de WQ5T

Idea Exchange

Technical Tidbits for the QRPer

Mike Czuhajewsi—WA8MCQ wa8mcq@verizon.net

In this edition of the Idea Exchange:

The Multi-Frequency Signal Source—*N2CX Quickie #78*
Counting Toroid Turns with a Digital Camera—*G3YTN*
Simple Portable Hamstick Support—*W1FMR*
Interesting Japanese Radio Web Site—*VA3YH*
Bypasses Added to Tiny Tornado—*W5USJ*
Tips for 3 Terminal Voltage Regulators—*G7MRV, NA5N*
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Alternative to Expensive Miniature Plug-in Fuses—*WA8MCQ*

The Multi-Frequency Signal Source

As many of you know, in the early 90s Joe Everhart, N2CX, sent me a couple of things he called Technical Quickies and offered to send me an endless string of them if I wanted to run them. Here is #78 in his series—

One aspect of homebrewing that I enjoy is using available parts to build something new. Of course having a deep junk box helps and mine has been growing since before either of my thirty-something sons was born!

This Quickie had its genesis when my good friend George Heron, N2APB, and I were brainstorming new projects. We had decided that we would hold a group buildathon at an NJQRP meeting with the project being the popular Tony Parks Ensemble RX (Ref 1), a multiband SDR (Software Defined Radio) using the fantastic Si570 oscillator chip. We quickly realized that the combination of a fancy-schmancy SDR project and its use of surface mount components would mean lots of opportunity for troubleshooting. Further, use of a computer with SDR software meant added things to get straightened out.

Past experience had taught us that there were several things that caused builders problems with the Ensemble. First was getting the Si570 operating correctly, second was getting the I and Q signal paths working properly and third, accurate winding and installation of the broadband transformer and bandpass filter toroid coils. A computer running the SDR software, an oscilloscope and several pieces of RF test equipment are the best way to go but a meeting with multiple troubleshooting sessions going on at the same time would be tough to properly equip.

In the end it was decided that the computer was necessary but that we could get away for most troubleshooting with test positions equipped with one loaded with the right software, a good tunable receiver to listen for the Si570 and a known received signal source. The signal source could be a low power transmitter operated into a dummy load but several of these in use at the same time could result in QRM that would complicate troubleshooting.

What we needed was something simple to use that would generate strong enough signals to hear in an insensitive Ensemble (one that was not working yet) that would cover the HF amateur bands to verify that each band was working.

After some discussion and lots of coffee we decided that we probably had all the parts needed to do the job. An earlier NJQRP kit project had been the Fireball 40 transmitter with used a 28.322 MHz crystal oscillator and a series of TTL divider chips to produce an output at 7.0805 MHz. One more divider would halve this again to 3.54025 MHz. By tapping off the original oscillator we could get more or less square wave outputs at 28.322, 14.161, 7.0805 and 3.54025 MHz. The third harmonic of the 40 meter output would have a usable signal at 21.2415 MHz.

Figure 1 is the final schematic diagram of the MFSS—Multi-Frequency Signal Source. Note that the 28+ MHz crystal oscillator has its supply voltage fed from the output of a 555 timer chip. This keys the oscillator on and off several times a second so that the signal is not a steady carrier. This is much easier to recognize than a plain dead carrier, particularly when it is very weak in a receiver. Additionally there is an LED that blinks in unison with the keyed signal to help in identifying it.

The dividers are common 74LS74 Schottky TTL devices that will operate reliably up to 10 meters. Power is provided by three AA cells. This is only 4.5V but experience shows that LSTTL chips work just fine at this voltage.

Outputs from each of the dividers can be picked off individually and fed to a foot or so of insulated wire lying near the Ensemble to be tested. In practice the 5 volt peak to peak 3.5+ MHz output sprays enough energy at its harmonics to work on the bench without the bother of selecting individual band outputs. DO NOT connect the output directly to the Ensemble input or you will fry something!

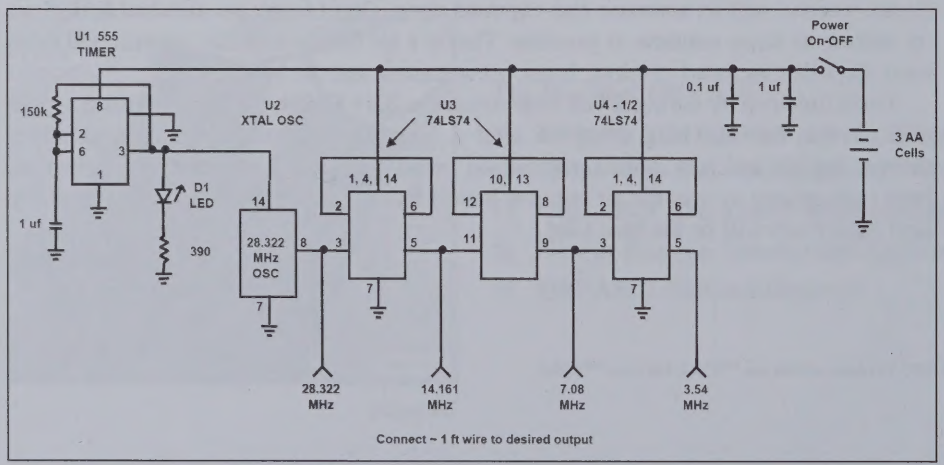


Figure 1—MFSS schematic diagram.

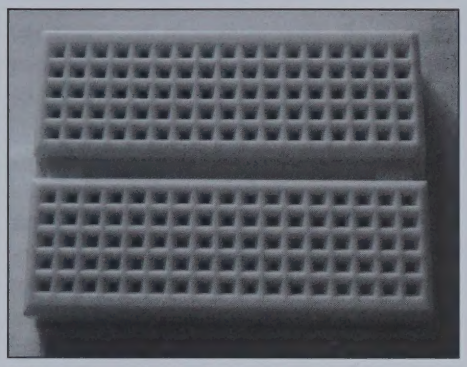


Figure 2—Typical plug-in experimenter strip. (Most are larger than this.)

For fastest construction the MFSS was build using a plug-in experimenter strip similar to the one shown in Figure 2. My favorite place to get them inexpensively is All Electronics (Ref 4). There's nothing particularly critical about any of the circuitry so this method is simple and useful for fast prototyping. I use it all the time for initial circuit checkout then build a more permanent Manhattan or perf board version for long term use. I have found that in time the springy metal strips inside the experimenter strips lose their springiness and tend not to give solid, reliable connections but if you keep this in mind you'll still get lots of fast prototyping from them.

While the MFSS was meant for checking a particular project it is probably not a bad thing to have around the shack for quick receiver go/no-go checks. If you do intend it for other than one-time use please build it in a more permanent manner.

References:

1. Info on the Tony Parks SDR kits is available at http://kb9yig.com/ If you go there you get hooked since Tony only offers the kits in bunches as he finds time to kit them. When they are offered they are snapped up quickly!

2. Detailed builders notes for the Ensemble Rx can be found at: http://www.wb5rvz.com/sdr/ensemblerx/

Please note that this info is for the original Ensemble and there is a link on this web page for the Ensemble II.

3. Fireball 40 documentation: www.njqrp.org/fireball40/fireball40.pdf

4. All Electronics solderless breadboard: http://www.allelectronics.com/make-a-store/item/PB-400/SOLDERLESS-BREADBOARD-400-CONTACTS//1.html

—DE N2CX

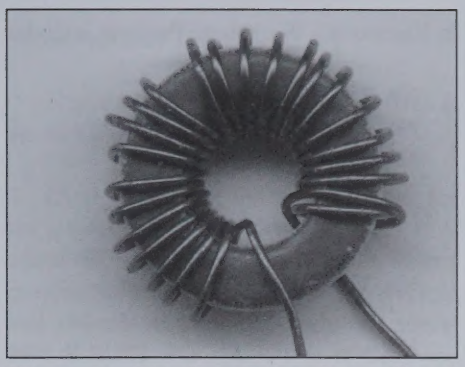


Figure 3—Whether done with a digital camera or flat bed scanner, a digital image of a toroid can be blown up on the computer screen and the turns counted very easily.

Counting Toroid Turns with a Digital Camera

This was posted to GQRP-L, the online GQRP forum, by Roger Hill, G3YTN—

This may have been raised before, in which case I'm sorry, but it has proved so helpful that I had to mention it to the group.

I've been winding toroids all afternoon. My eyes are not what they used to be, and using a toothpick to count the turns on the cores was proving frustrating. I needed, say, 60 turns and kept on losing count around the 43 mark!

So I asked my wife to help me check them, and she came back in a few minutes with the first one, with a count that was a couple of turns off, and she also said, 'and you've got a crossed turn'.

When I asked how she knew that, she called me over and showed me. What she had done was blindingly (no pun intended!) obvious. She had photographed the core against a sheet of white paper, loaded the image into her computer, and simply zoomed in until the core filled her screen. Counting the turns was trivial, and crosses were obvious. She used Picasa and/or Irfanview on her Windows machine; Ristretto or something similar would of course work on Linux.

So after that I just wound each toroid until I reckoned I was close, within 2 or 3 turns, then used the screen, and added or subtracted to suit. Such a simple solution!

—DE G3YTN

WA8MCQ comments: Another possibility is to use a flat bed scanner. I grabbed a random toroid and wound a random number of turns on it, then scanned it. Figure 3 is the result. (I scanned this one at a resolution of 600 DPI although the 300 DPI version is still perfectly good for counting turns.) Blow it up on the screen and counting turns is quite easy. (And I even had a crossed turn, although it was at the end of the winding and easily corrected.)

Simple Portable Hamstick Support

This tip comes from longtime QRPer Jim Fitton, W1FMR—

I put together a simple Hamstick support using readily available parts. It works great at the beach or in a salt marsh and

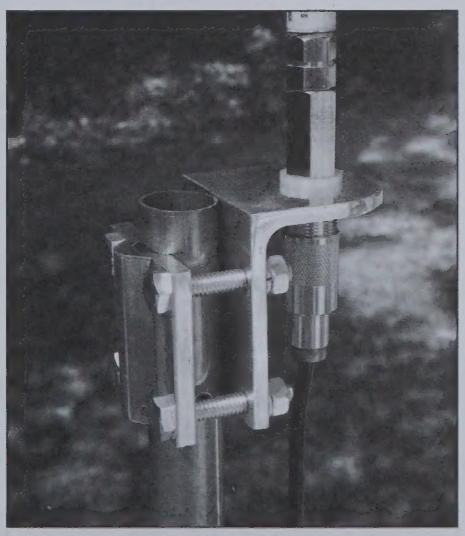


Figure 4—A truck mirror mount for a CB antenna and piece of copper pipe make a good portable Hamstick antenna support.

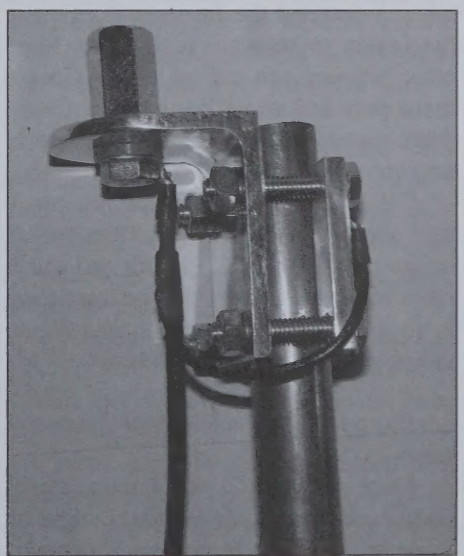


Figure 5—Alternate method of connecting the coaxial cable to the antenna using a terminal lug.

uses a 3 way CB truck mirror mount attached to the top of a 5 ft copper pipe from a building supply store. Interesting that the mirror mount can be configured vertically, horizontally, or at 45 degrees. Figures 4 and 5 show it, with two different methods of connecting the coax.

The pipe pushes easily into wet beach sand or salt marsh. Tuning the Hamstick (type) antenna requires a shorter stinger for a low SWR but it can be easily cut down. Put the stinger in a vise and score around it with a hacksaw or file then give it a tap with a hammer and it will break off. You must wear safety glasses!

Tonight on the way home I stopped and pushed the pipe into the soft mud of a salt marsh and worked a bunch of European stations with QRP. Of course I live in a seacoast town so this may not work for everyone, but finding what works at your location is what the fun of antenna experimenting is all about.

—DE W1FMR

Interesting Japanese Radio Web Site

Ying, VA3YH, passed along the URL for a web site that he said has a lot of construction articles and might be of interest to the readers:

http://www.icom.co.jp/beacon/kousaku/

It's in Japanese; he suggested using Google Translate to convert it into English. I'm currently using the Chrome browser from Google which made it quite easy; when it detected the Japanese it gave me the option to translate it. If using some other browser you can go to the Google home page and select Translate (in a pull-down menu under "More"), or just go to http://translate.google.com.

Cut and paste the URL into the block that appears and click on Translate. It comes up with a URL to click on, which takes you to the translation. The translation is rough, of course, but you can figure things out and get the basic ideas.

Ying sent some additional comments later—

Since QRP ARCI is an international club, your world wide members might be interested to read it in their own language. [Google Translate supports over 50 languages.]

There are up to 78 construction articles in Electronics Workshop. Projects include:

No. 75: Microphone stand.
No. 55: AM shortwave receiver
No. 49: Antenna anywhere
No. 45: Power meter
No. 44: 7 MHz antenna tuner
No. 42: Digital capacitance meter.
No. 33: 7 MHz CW receiver

I know some of the projects use Japanese parts but I think some of the construction techniques are interesting.

The following are some of my homebrew projects:

http://yhum.dyndns.org/qrp/

http://www.qsl.net/va3yh/photo4.htm

If any of QRP ARCI member visit Ottawa, don't miss the War Museum and see if they can decode the CW message on the Museum wall at http://www.qsl.net/va3yh/museum.htm

And don't forget to try a bottle of Morse Code Shiraz, http://www.henrys-drive.com/our-wines/ morse-code-shiraz

—DE VA3YH

Bypasses Added to Tiny Tornado

In the last issue Chuck Carpenter, W5USJ, shared some modifications to the Tiny Tornado kit (essentially the same as the Pixie minimalist transceiver). There was actually another modification that was not mentioned, which was adding a pair of bypass capacitors that were not in the original kit. They appear in his schematic but no attention was called to them. When he received his copy of the Quarterly *he sent me this note—*

I forgot to mention that I'd added two bypass capacitors to the circuit. The power bus was hot and I added one at the collector of the oscillator and one at the input from the power source. Those two capacitors are not part of the original Tiny Tornado kit. I added them to make it more stable. That was something I should have indicated in case someone who has a TT took notice [or in case someone wants to build one from this schematic].

—DE W5USJ

Figure 6 is part of Chuck's schematic that appeared in the last issue. I annotated it to indicate which capacitors were added.

—WA8MCQ

Tips for 3 Terminal Voltage Regulators

The subject came up on the GQRP group on Yahoo.com in December when Martin Barfield, G7MRV, finished the power supply for a project he was building for a friend and was having trouble with the outputs. It produced positive and negative 12 volt rails using 7812 and 7912 regulators (the 1 ampere version in TO220 packages). The positive rail was good (11.8 volts, within specs) but the negative rail was reading 14.4V. A discussion followed, and here are some pearls of wisdom.

From Paul Harden, NA5N—

First I would check the pinout of the

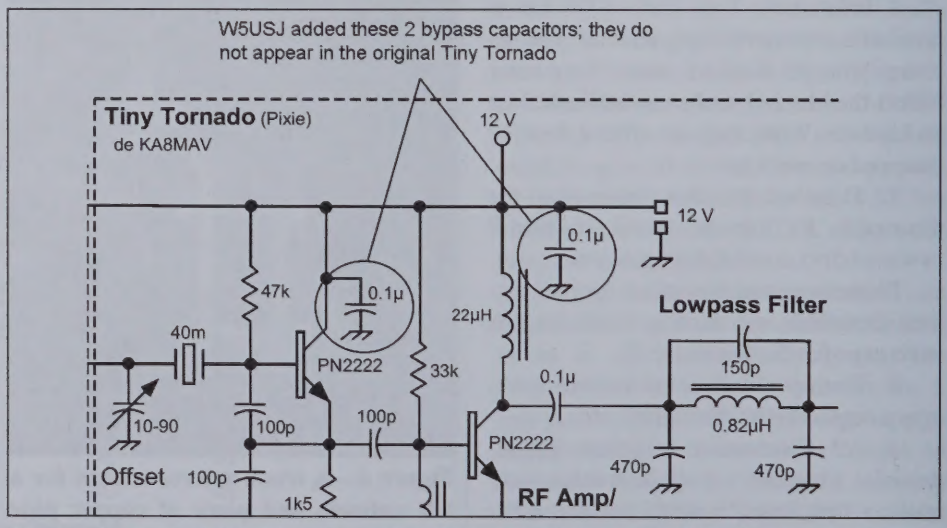


Figure 6—Part of the Tiny Tornado schematic that appeared in the last issue. The two capacitors indicated were added by W5USJ and were not part of the original kit.

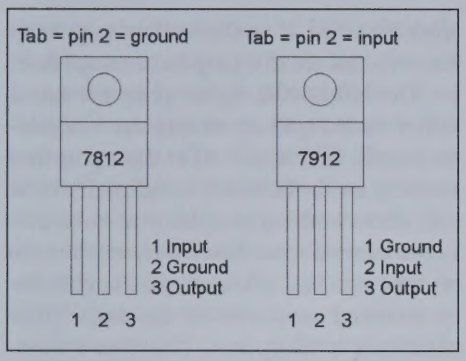


Figure 7—Regulators in the 78xx and 79xx family have different connections, and the metal tab can be ground or at the same voltage as the input depending on the version.

7912 as it is different from the 7812 as follows. I'm assuming you're using the TO-220 package variety.

7812 (+12V reg) Pin 1 Input, Pin 2 Ground, Pin 3 Output, tab/pin 2 Ground

7912 (–12V reg) Pin 1 Ground, Pin 2 Input, Pin 3 Output, tab/pin 2 Input

Pin 1 is the left-hand pin on the TO-220 package. Note that the metal tab on the 7912 is not ground. (See Figure 7.)

Second, often the TO-220 package does need some minimal load, usually 5 mA or more. I usually use an LED biased for about 8 mA (a 1.2k to 1.5k series resistor for a 12 volt supply) to provide this minimum load. Obviously, it can serve as a power-on indicator as well.

Third, the TO-220 package requires V_{input} about 1.2 to 1.3 volts higher than V_{output} (the dropout voltage). Below the dropout voltage, the ""regulated" output more or less follows the input voltage.

—DE NA5N

G7MRV later reported that he had solved the problem—

It turned out to be the requirement for a minimum load. With the addition of an LED and a 1k series resistor the negative output was bang on, 12.02 volts. The positive line likewise is within tolerance at +11.84 V. Oddly, the positive line was stable without the load. *—G7MRV*

Someone else said that they didn't see minimum load current mentioned in the regulator data sheets. NA5N had this reply—

Actually it is there, but rather subtle. Here's the data sheet for the ON Semiconductor 7912:

http://www.onsemi.com/pub_link/Collateral/MC7900-D.PDF

On page 5 for the MC7912AC, look for the parameter LOAD REGULATION. It states that the load regulation for output currents of 5 mA to 1.5A is 46 mV typical and 150 mV maximum. So why not specify it to 3 mA or 2 mA or 1 mA? Behavior and stability concerns were no doubt encountered below 5 mA on some units. This is telling you the device is not specified or guaranteed for a load current less than 5 mA. (I said it was subtle!)

[WA8MCQ note—The AC suffix version has an output voltage tolerance of 2%. The B and C versions are 4%; the maximum load regulation number is higher, but the range still starts at 5 mA.]

I learned this the hard way years ago on TO-220 regulators where the load was completely removed and output voltage went awry. The light load of an LED, as Martin confirmed for us, is usually sufficient. I have not experienced a no-load problem with the 100 mA TO-92 package types. *—NA5N*

WA8MCQ note—

I checked the old Motorola MC78xx data sheet and it also indicates a minimum load of 5 mA in the line regulation spec. That value also appears in the National Semiconductor LM78xx sheet dated May 2000, the Fairchild LM78xx sheet dated April 2010 and ST Microelectronics Sept 2010 78xx. The National data sheet for the LM79Lxx series, the low power 100 mA version, gives a 1 mA figure.

While poking around the National web site I came across this info in one of the FAQ sections—When using the surface mount LM78L and LM79L low current series, all of the multiple ground pins should be connected to a large copper trace since heat is conducted out of the chip through the leads. (Using multiple ground pins for heat sinking has been a common design feature for a lot of things for years.)

I'm glad Paul mentioned the different pin connections between positive and negative versions. I very rarely use the negative regulators and had forgotten about that, and almost wired one incorrectly a while ago.

Two Pinouts for Plastic 2222A Transistors?

Chuck Carpenter, W5USJ, posted this to the Rock-Mite group on yahoo.com a while back—

While working on a project I discovered that there are two versions of the plastic P2N2222A transistors.

I was attempting to test a circuit with the P2N parts and it didn't want to work. I then tried it with a metal can version and that did work. I tried other PNs that I had and had the same problem.

For some reason I tried turning the P2N part around. Wow, that worked! The pinout is reversed. I've checked these parts in a DMM that has a transistor test (HFE) mode. That confirmed my findings.

Looking at the P2N parts with the flat face forward and the leads down, the usual pinout from left to right is E B C. The reversed part pinout with the same orientation is C B E. So if you need to replace any P2N parts, verify the pinout before you solder them in the circuit. *—W5USJ*

After the topic was discussed for a while I did a bit of digging and made this post—

When Chuck first posted about the P2N2222A I wondered why he called it that; the correct part number is PN2222/PN2222A. I assumed it was a typo. Between Mouser and DigiKey I counted 9 different companies that currently make the PN2222/2222A, including ON Semiconductor. (In case there is anyone who doesn't know this, that is a division that was spun off from Motorola quite a few years ago.)

All data sheets, including the one from ON, show the pin order as EBC, when held with the flat side facing you and the leads pointing downward. I told Chuck the ones he had may have been manufacturing defects or counterfeits.

I recently discovered that there really is a P2N2222A, a plastic cased transistor. It is made by ON and apparently no one else, and the data sheet for that one shows the pin order as CBE, which Chuck had encountered. I don't know what the difference is between the two (PN vs. P2N) although a quick scan of the specifications on the data sheets showed them to be pretty much the same. ON calls the P2N an amplifier transistor, and the PN a general

purpose transistor. So, ON is currently selling both PN2222A and P2N2222A, virtually identical transistors with different pin orders. I'll leave it to someone else to figure out what the difference is between the two, but it looks like the mystery may be solved. *—WA8MCQ*

So it appears that Chuck simply ordered the P2N2222A instead of PN2222A without realizing there was a difference. However, you can still have transistors with the latter number that have reversed pinouts, as pointed out by WB4ONA, who posted this—

I bought a bag of plastic TO-92 transistors labeled "2N2222A" in Singapore (Sim Lim Tower) for just a few cents apiece. The collectors and emitters were reversed, and the measured HFE from part to part was all over the map; much more so than with "real" PN2222A's I have from Fairchild. These dubious parts are most likely not true 2N2222A transistors but remarked devices of a similar type, probably from China.

These "fake" parts may work fine in simple switching circuits, but I will not put them in any circuit that expects a real P2N2222A part.

Today Octopart says Newark, or Element-14, or whatever they're calling themselves this week has Fairchild PN2222A's for six cents apiece in unit quantity. At that price, why take a chance? *—WB4ONA*

Alternative to Expensive Miniature

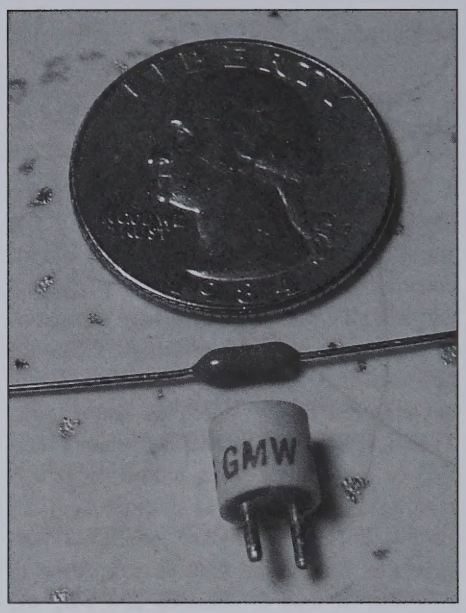


Figure 08—Bottom, GMW miniature cartridge fuse; middle, leaded Pico fuse. (For those not familiar with US coins, this one is approximately 0.95" or 24 mm in diameter.)

Plug-in Fuses

The miniature plug-in fuse at the bottom of Figure 8 is type GMW, and is currently in production. You might occasionally see these mounted on circuit boards or in holders on equipment. Unfortunately they are fairly expensive, costing several dollars each. That's a bit much to replace a single fuse that blew, and if you're troubleshooting and blow more than one it quickly gets very painful. Fortunately there is an alternative available for one tenth the price, if you're willing to give up the convenience of a plug-in cartridge fuse.

The HP 8640B signal generator has 5 GMW fuses, split up among the 3 regulator boards. In this case all of them plug into contacts on the boards. I accidentally blew one while working on mine and fortunately the internal spare fuses were all there so no time was lost. (A small plastic container mounted atop one of the large filter capacitors holds spares.) However I wanted to replace the spare I used and get more of all 4 values to be safe.

I looked at DigiKey, Mouser, Allied and Newark. All carry at least some of the GMW fuses (many as non-stock items) and the prices are typically between $6 and $7 each. If you think that's bad, it could be worse. The military version of the GMW is the FM01 family, and those are around $24 each (!).

If you're willing to give up the convenience of a plug-in fuse you can save a lot of money by using Pico fuses, from Littelfuse, in the center of Figure 8. They've been around for years but I never needed to order them before. They resemble small leaded resistors, and the particular type I got from DigiKey was $0.63 each. It's the Littelfuse 251 series, 125 volts, fast blow (the same specs as the GMW).

DigiKey numbers are F2353-ND for 3/4A; F2313-ND, 1A; F2314-ND, 2A; F2315-ND, 3A. (Those are the values used in the 8640B. Other values are available.)

Installing them on one of the regulator boards in the 8640B is quite simple since

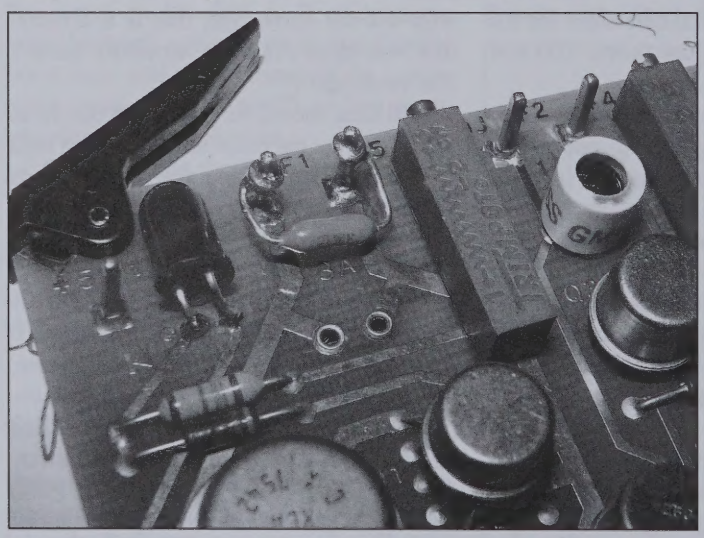


Figure 09—One of the HP 8640B power supply regulator boards that has two GMW fuses, with one replaced with a Pico fuse.

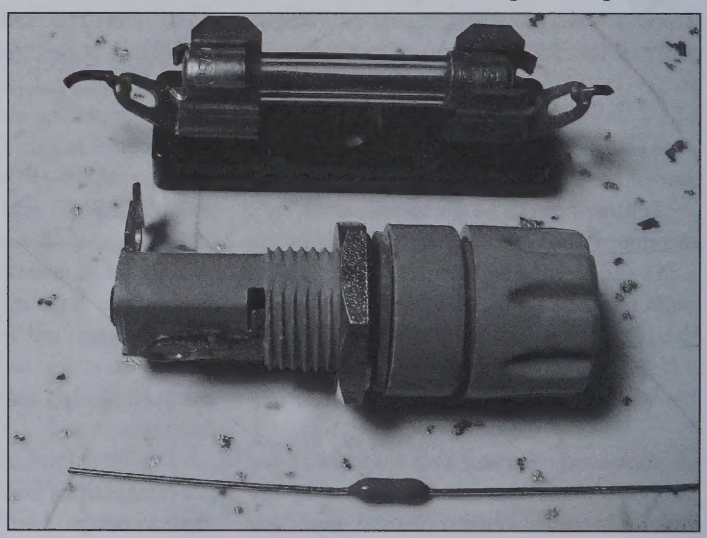


Figure 10—If space is at a premium in a project and you are willing to use a hard wired fuse, the Pico (bottom) allows considerable space savings.

there is plenty of room. I had originally planned on inserting the leads into the contact holes and soldering in place but later decided to solder them across the two test points instead. (See Figure 9.) Those are located on both sides of the fuse, presumably so current draw can be measured. This way the socket is still available in case I stumble across a really good price on GMW fuses at a hamfest.

I've seen pieces of equipment over the years that had holders for the plug-in GMW/FM01 fuses and the Pico fuse wouldn't work with those, although you could solder them across the solder lugs on the rear of the holders. It's not very elegant or as convenient as a plug-in replacement fuse, but a lot cheaper.

The Pico fuse is also a good option for reducing size (and expense) if building a device where space is at a premium and you are willing to forego the convenience of a plug-in fuse. Most people would use a traditional (and large) cartridge fuse for that, so the space saving would be considerable (Figure 10). Keep in mind that this does require ready access to a soldering iron and tools if the fuse blows, so this is not recommended for something that will be used on Field Day, backpacking, vacation, etc., where there is not a soldering iron handy. (I've seen a lot of things over the years that have soldered-in fuses, though, so this technique does get used.)

I later learned of the SR-5 and SR-5F series from Bussmann, which also makes the GMW. Although it initially appeared to be the same as the GMW, the diameter and height are somewhat greater, and the pin/lead diameter is smaller, so they would probably not work with a holder for the GMW. They could probably be soldered onto a board with no problem, although they are more expensive than the Pico fuses, so I'm sticking with the latter.

I did look briefly at online auction site eBay for GMW fuses but the prices were not great and selection of values was limited. And I'd be cautious of something similar but at a much lower price. Anything and everything can be counterfeited and sold for much less than "genuine" parts, but I'd be very hesitant with taking the risk when it comes to a safety related item like fuses. (I've read too many horror stories about cut-rate fuses that took much more overload current to blow than they should, or, in some cases, refused to blow at all.)

—DE WA8MCQ

The Fine Print

You know the drill—send your info to Severn any way you can get it here (e-mail, snail mail, floppy, CD, handwritten on a napkin, etc), or tell me where you found something of interest on the Internet. We take care of the rest, editing, redrawing, etc. The readers are waiting!

●●

Is it Time to Renew???

Your basic QRP ARCI membership (and member number) will last forever ... BUT, your continued subscription to QRP Quarterly requires you to be an active, dues-paying member!

Renewal notices are included on your mailing label, and also sent by e-mail (if we have your address). You can also check your expiration date online at the club web site: www.qrparci.org — just click the "Member Lookup" button on the left side.

Send your renewal online using PayPal, or by check to the QRP ARCI Secretary using the form on page 64.

While you're at it ... check out the QRP ARCI Toy Store for QRP clothing and accessories, past FDIM Proceedings, and other items to show your enthusiasm for the QRP side of ham radio!

FDIM Wrap Up

Norm Schklar—WA4ZXV fdim@qrparci.org

We had another great FDIM this year. Thanks to everyone that attended and helped make it a success.

- We registered 321+ folks for FDIM.
- We had 25 different vendors preregister.
- We had 15 register ahead of time for Show and Tell.
- We had 16 Registered in advance for the homebrew contest.
- We had 21 spouses registered for the Sticthin' event.
- We had 35 registered (49 actually built kits) for Build-a-thon.
- And we had 18 folks volunteer in advance to help where needed.

Wednesday evening we setup for registration and were about to start when we realized that several of the badges didn't print right. We quickly pulled the bad ones, and started registration. About 60% of the total registrants get processed on Wednesday evening. After being registered, it didn't take most folks long to find a chair and start catching up on what they have been doing since last year. About 11:00 most were talked out and we headed out.

Thursday morning was registration for the rest of the seminar folks and the start of the sessions. We started on time and enjoyed three sessions in the morning before the lunch break. After lunch we started our afternoon sessions on time. I really need to come up with a better way of picking a winner for the door prizes. Now everyone knows my families birthdays.

The first two speakers were a little short. It didn't hurt the quality of their presentation, but it did put us ahead of schedule. George was taking a break before his session, and since it was early, we panicked because he was not in the room. He showed up just in time and all was well. We did put up a YouTube video showing off Diana Eng's work which helped fill the time. This wasn't planned as time filler, but worked out great. After the lunch break, we started on time. We had three nice books to give away, and I used them after the breaks and after lunch. It helped get the room calmed down.

The Buildathon seemed to get started OK. I know Rex was busy doing last minute preparations, but it looked like everyone was having fun. There were about 50 building kits.

Twelve vendors had preregistered for Thursday evening. We had plenty of tables and room. We were glad to see a good assortment of Show and Tell and homebrew projects for viewing. We opened the room to all about 7:30. There were no vendors bringing in any bulk product or materials, so no reason to make folks stand in the hall. It was about 8:30 before the room started to fill up. But when it did, it was busy for about an hour and a half. It seemed like everyone was having a good time. "Pickin and grinin'" started about 10:30 and I left about 11:00.

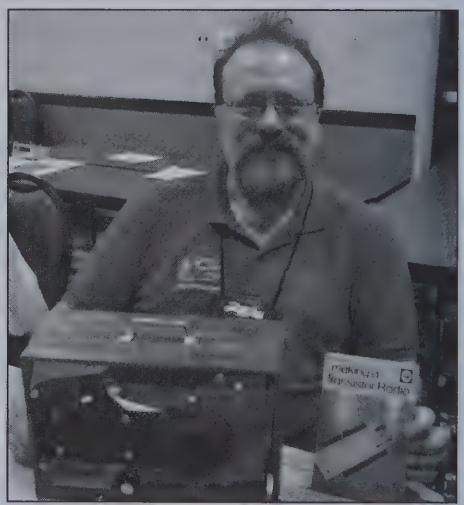
The 7:00 Cube Radio talk started out with about 60% of the seats taken, but we sent early arrivals for Vendor Night over and ended up having to add chairs in the back. We opened up just before 8:00 and the room filled fairly quickly. Seventeen vendors had registered and they all seemed to find a comfortable table. We had 8 additional tables setup. We ended up with two empty tables. The build-a-long seemed to go OK. Streaming the video was done by Steve Fletcher, and several folks watched or participated from home. The attendance from FDIM folks was thin but those there built a kit. Elecraft came by and set up a table. Their new radio was the talk of the day, so everyone enjoyed their visit. Then later Steve Fletcher did a video stream of the new KX3.

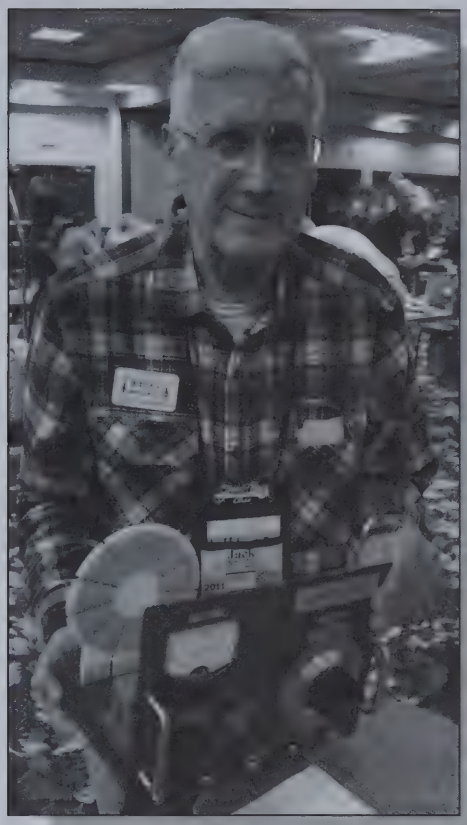
Saturday afternoon Kathy and I went through the door prizes and did the predrawing. Kathy read out a list of the vendors that participated. The banquet started on time and the hotel staff helped get tables to the line without having a super long line. From what I heard, most liked the meal. We were on time and Kathy easily handled the awards and prizes.

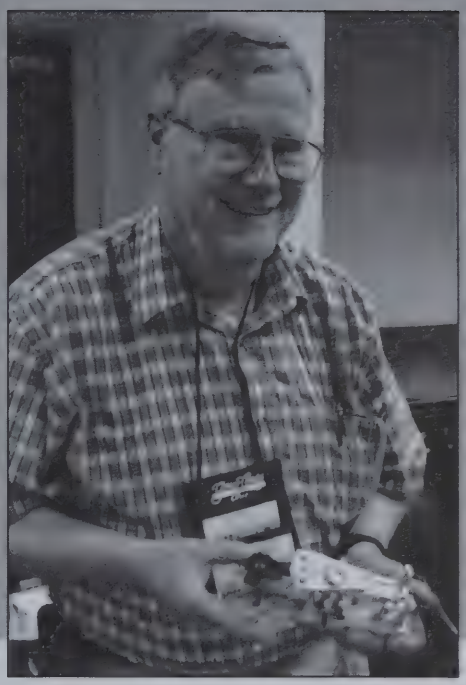
So from a FDIM chairperson's perspective, it was great. Thanks everyone that took time to mention how great it was.

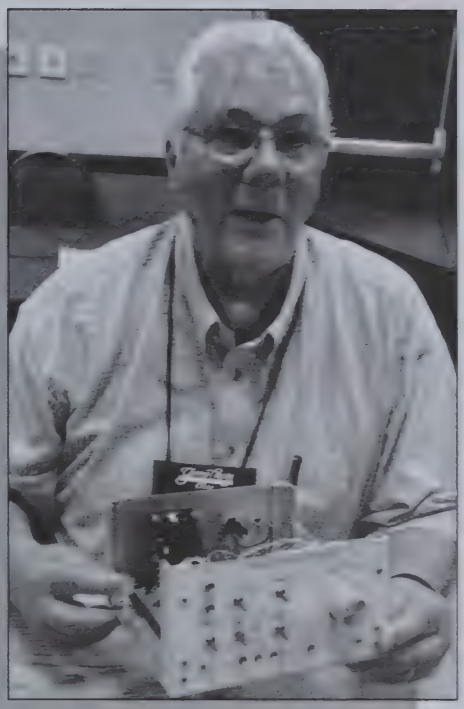
—Norm Schklar, WA4ZXV

The FDIM 2011 Homebrew Contest Story in Photos









More FDIM Photos
on the next page...

THANK YOU for FDIM Prize Donations!

I wish to give a great big thank you to those who donated prizes to FDIM 2011. We are honored these sponsors chose to help us celebrate the 50th anniversary of QRP ARCI. I have listed each sponsor in alphabetical order below and would like to encourage everyone to visit their web site. I not only want to thank them for their support of FDIM 2011 but also for their support of QRP.

Thank you,
Kathy Bromley, WQ5T, Vice President QRP ARCI

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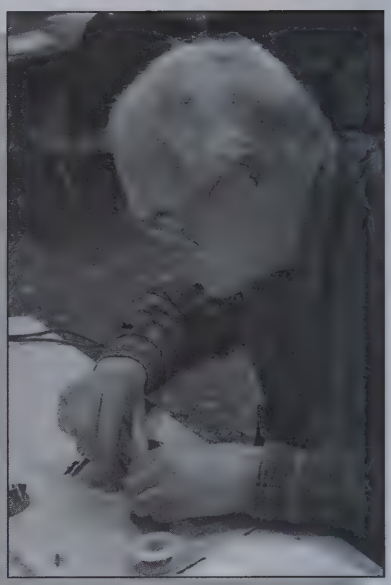
A Photo Record of the FDIM 2011 Build-a-Thon



QRP Clubhouse

Timothy Stabler—WB9NLZ wb9nlz@yahoo.com

Another Summer has arrived and I am sure that everybody has projects they are working on. For the last couple months, I have had my Father-in-Law and his good friend putting in my 12x25 foot "man-cave." I get the materials and they put it all in. Now that the project has been finished. I can unpack boxes from our move to our new home and set up my shack, workbench, TV room and whatever else I want in there. My former "shack" was a little over half the size of this room, so I do not expect space problems.

Some of the Buildathon participants. (Photo: VE3QEE)

A couple notes before I start here. First I want to apologize to Frank Roberts, VE3FAO, for not including his report in my last column on the Peel Amateur Radio Club. I had gotten his email too late for my Winter column and told him it would be in the Spring column. Well, we all know what can happen to emails when many others come in. I went to clean out my saved stuff and there was Frank's email. So I have included it here. I know the Peel Club is not necessarily a QRP club but their buildathon is something I feel more clubs should think about getting into.

Second, although in my last column I did not think I would be at Ozarkcon, I did make it. That weekend, my XYL had been thinking of attending a nursing conference in New Orleans but decided she had other things she had attend to here in Indiana. My daughter will be married before you read this, so you will understand things are very hectic around here right now.

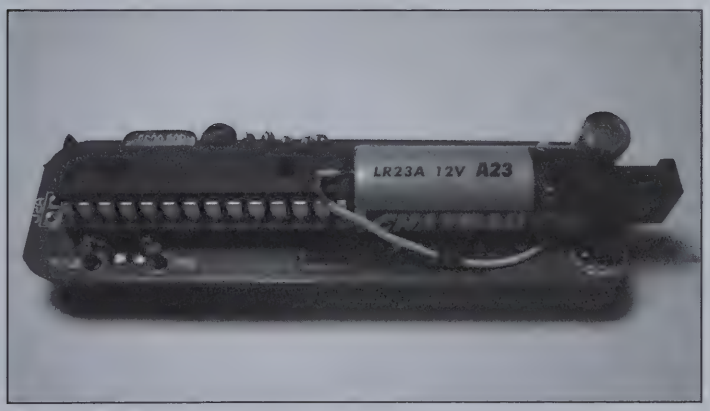
Thirdly, I guess, is my apology for this possibly being a shorter column. I try to email some clubs to get input for the column but after just getting over the wedding shower (for which I was "volunteered" to be the photographer) and planning for the wedding (in 4 weeks at this writing), time has been very short for me to do radio or anything else. If you are in a club or some group, please send me some stuff for my next column, due into the editor by September 1.

Peel Amateur Radio Club Fall Buildathon

Each spring and fall the Peel Amateur Radio Club in Brampton, Ontario Canada holds a Buildathon for its members. For their 15th semi-annual Buildathon they chose the Superprobe based on a design by Luhan Monat of Mondo Technology. It's a small hand held probe with 17 functions (http://mondo-technology.com/index.html). The club designed their own double sided circuit board and adapted a case from Mouser. There were 20 units built and each one worked the first time. Thanks go to many of the Homebrew group who contributed to the project, but notably Gord Kennedy VE3GKN for designing the circuit board, Simon Claughton VE3SFC for milling the cases and Peter Ayearst VE3POA who did the Beta testing.

Ozarkcon 2011

Again, this was a great weekend for everyone who attended Ozarkcon. Ozarkcon is sponsored by the 4 States QRP Group, www.4sqrp.com. The meeting was held at the Stone Castle hotel in Branson, MO. In 2010, Joe Porter, WØMQY, and others behind Ozarkcon, contracted with the hotel to have Ozarkcon there for the next 5 years. What is nice is that the hotel will allow 5 extra nights to stay at the hotel at the cost of the meeting nights when you book your room. The dates for the next 4 years are on the website, www.ozarkcon.com. If you might be interested in coming, or just looking, go to



Inside the Superprobe.

Superprobe in the case.

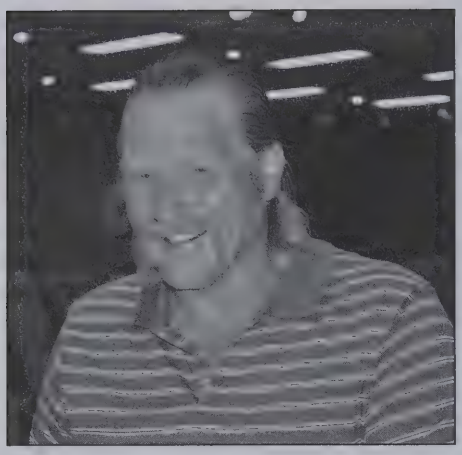


Photo 1—Rick Swan, White River Historical Society.

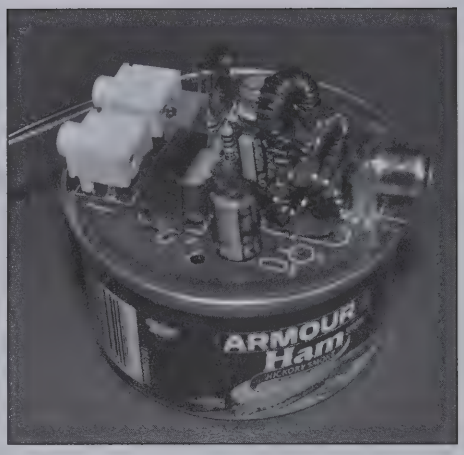


Photo 2—Dave, NMØS' Hamcam transceiver.

this site and you can download everything (if it is still there) pertaining to this year's meeting. Early in the year, this website will have information about the current year's meeting, along with registration forms, etc. At the end of registration for this year, 111 people had signed up from 16 states including Uncle Cy, the Led Guy, K1TES, who drove in from Maine, gas prices and all.

The meeting starts with registration at 4 PM Friday afternoon. Included in your materials are two tickets for prize drawings held in between the talks on Saturday. At 6 PM, there was a banquet dinner. This year at the dinner, Rick Swan, (Photo 1) Vice-President of the White River Valley Historical Society, was introduced and gave a talk about the area including The Bald Knobbers, one of the musical theaters in town. It seems that after the Civil war, all sorts of crooks lived in that area. A group got together to get rid of them and did. They called themselves the Bald Knobbers as a fire would be set on top of one of the hills, basically a "bald" knob, or hill due to the abundance of limestone forming these knobs, to signal a meeting that night. With time this group became a nasty vigilante group which was broken up under the threat of state militia coming in. When a family came into town to start a musical theater, they wanted to use a name from the area, so chose this group's name but added an extra "b" to the name for their theater (www.baldknobbers.com).

Following dinner, the building workshop was held led by Dar Piatt, W9HZC, and Darrel Swenson, KØAWB, of the Midwest Homebrewers and QRP Group. The kit this year was the FB minimalist transceiver, designed by David Cripe, NMØS, who also designed the 4SQRP NS-40 transmitter. The transceiver kit is called the "Hamcam" as the circuit board fits on top of a deviled ham can like you see in the grocery stores. (Photo 2) The workshop is limited to 40 people. 20 started at 7:30 PM and 20 at 8:30 PM. You could stay until you were finished with your kit. (Photo 3) Each workshop took a little longer than the hour usually allowed due to a limited number of assembly manuals.

At the same time, three other sessions were going on. There was a Dummy Load QSO party for the Ozarkcon station, K0N, operating at 7040 KHz. People bring their portable rigs, dummy loads (antennas) and QSL cards to Ozarkcon and during the meeting work the KØN station from their rooms. QSL cards are exchanged and on Saturday at the end of the meeting, a QSL card is drawn for a prize. Phil Anderson, WØXI, held an ultrasonic QSO party using ultrasonic transceivers (http://www.midnightscience.com/ultrasonics.html). A note here, Phil is now looking at radio astronomy as a new project. Also held was the "Wacky Key" Contest. Last year, a potato-carrot combo won the prize. Lastly, at 9:30 PM some people got together with their guitars, banjos, mandolins or whatever, for the evening QRP musical session.

The next morning, 6AM-9AM, the hotel put on a complimentary breakfast for the QRPers. Late registration was held 7AM-9AM. At 7 AM Bart Lawson, WØIIT, the Station Master for KØN, had the station up and running for the day (Photo 4) and the QRP flea market, vendor fair was open for the day.

The meeting began at 9AM with opening remarks by Terry Fletcher, WAØITP. This year's meeting had the highest number of registrants for an Ozarkcon. It was announced that the Titanic museum (not that far away from the hotel) was running a special event station, WØS that could probably be worked using the dummy load setups at the hotel. He then introduced Greg Pryon (Photo 5), a producer of the daily news show on the local radio station, KRZK. Greg welcomed everybody to

Photo 3—Ozarkcon building workshopwas a busy scene!

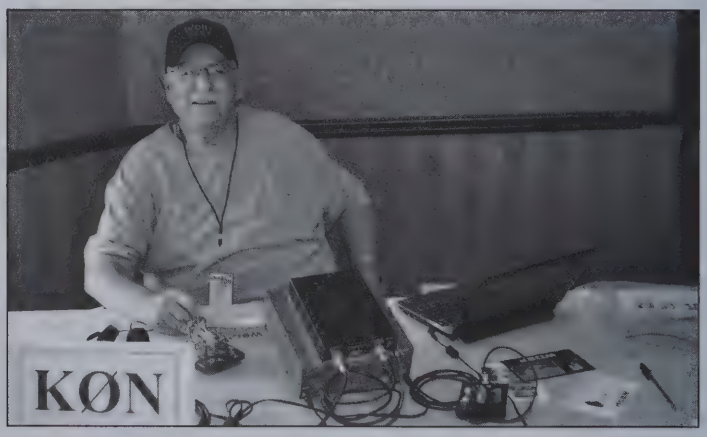


Photo 4—WØIIT at the helm of the KØN station.

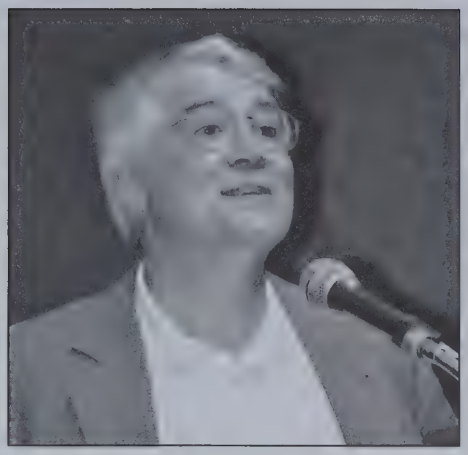


Photo 5—Greg Pryon of KZRK.

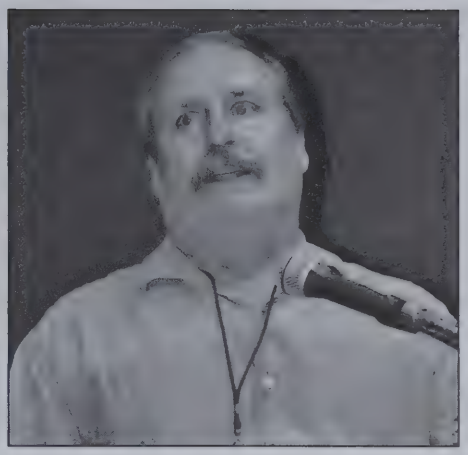


Photo 6—Ward, AE6TY the SDR guy.

Photo 7—Marshall, WØOTM.

Branson. He talked of his early radio work and that now, much of the "work" is done by computers. He mentioned that he had put a series of announcements on the hard drive to be used later to be used later, and then went out for coffee. Some people were very surprised to see him when they had just heard his announcements on the radio.

The first talk of the day was "Software Defined Radios" by Ward Harriman, AE6TY (Photo 6). He pointed out that to do digital signal processing; one does not need to know the math. He then briefly went through material which he has published in earlier issues of this publication. He suggested going to his website, www.ae6ty.com, to read his articles on SDR. On his website, he also includes information (with programs and tutorials) on the Smith Chart.

The next talk was on the "Iowa High Altitude Balloon Project" (http://www.ihabproject.com) by Marshall Dias, WØOTM (Photo 7), and Terry Fletcher, WAØITP (Photo 8). Marshall talked of the balloon itself. In IHAB-1, there was EPS foam payload box carrying a weight of 1640 grams including a Canon A440 camera, which can be programmed, hand warmers to keep things warm at high altitudes, and a 14.066 MHz beacon. In IHAB-2, the lens cover was removed from the camera; a video camera was added plus an APRS at 144.34 MHz. In IHAB-3, the APRS was shifted to 144.39 MHz and DTMF control was added to the home base to turn the beacon on and off. When the helium balloon bursts, the payload is returned to ground by a 36" parachute. A piece of the burst balloon was brought to the meeting for people to see. It was quite thin due to the altitude at which it had burst.

The beacon has been heard in many different states East to West (100+ contacts) as well as countries including Canada, England, Scotland, Germany, Australia, Panama and South Brazil. Not bad for 1.7 watts. There is a chase team ready at each launch. In IHAB-2, the winds caught the balloon and it came down in Rockbridge, Illinois near Lake Michigan. Also, in IHAB-2, the pictures came out very well and have been stitched into a very nice panorama taken at about 87,000 feet. This project is totally funded by individuals. You can send in a $25 donation and receive a 8" by 12" copy of the panorama photo. A recent idea is to put an experiment in a 35 mm plastic film canister and put on in a balloon flight. The website has ideas for such projects.

Terry talked of the radio beacon. The radio was built using Manhattan construction to make changing sections easier. By IHAB-2, a keyer was added (the 4SQRP keyer), the antenna coupler was modified and Class E final was included for lower current consumption. He then went over the schematics for the beacon, power and switch which may be included in the future on his website (www.wa0itp.com).

The next session was the introduction of new 4SQRP kits. Jim Kortge (Photo 9), K8IQY, introduced his new receiver, the SS-40. This is sensitive and quiet and has been designed to go with the 4SQRP NS-

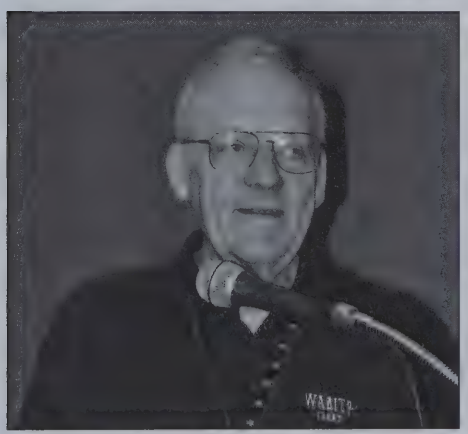


Photo 8—Terry, WAØITP.

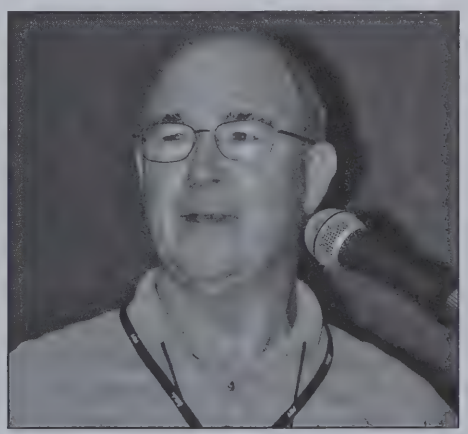


Photo 9—Jim, K8IQY.

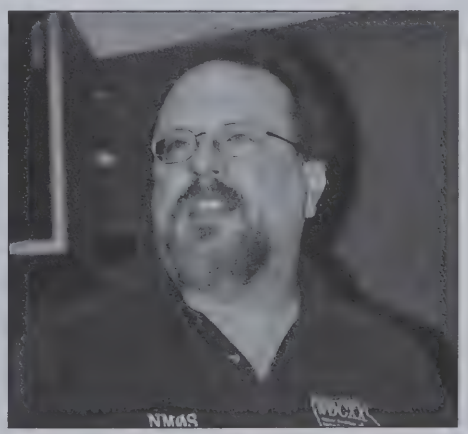


Photo 10—Dave, NMØS.

Photo 11—Jerry, W5JH.

Photo 12—Dar, W9HZC.

Photo 13—Joe Eisenberg, KØNEB at the Titanic special events station.

40 transmitter and the 4SQRP Magic Box, a transmit-receive switch using a single antenna output. David Cripe (Photo 10), NMØS, talked about his Hamcan transceiver which had been the kit used the night before at the building session. If interested, both kits are available from 4SQRP using Terry's site (www.wa0itp.com) or the 4SQRP site (www.4sqrp.com). These kits use thru-hole construction, making them very easy for beginning builders. One comment here, however. Purchased kits do not include the assembly manuals. These manuals, which are very good, may be downloaded from Terry's website. This same website has information on all kits being offered by the 4SQRP Group.

Following lunch, Jerry Haigwood (Photo 11), W5JH, spoke on "Dipoles, Zepps and Feedlines." He spoke of various feedlines. His favorite is an open line which has virtually no loss. He uses #14 wire and spacers, both easily gotten at your local Home Depot or similar store. He gets the wire in 50 foot rolls, 1/2"x10 foot CVPC and 8" or more ties. He told of the Zepp being for a single band and showed various configurations. He pointed out that the double Zepp is full wave, center fed and needs a 50 ohm transmitter. It should be installed as a flat top and was once popular as a 2 band antenna.

Jerry then got into antenna patterns. He talked of a generic doublet, a multiband, center fed dipole with 2/5 wavelength at the lowest frequency. He want to design antennas so built-in antenna tuners can handle the antenna. He then demonstrated a tennis ball launcher for antennas (although your dog will also love it).

The next talk of the afternoon was "Elmering, Keeping it Interesting and Fun" by Dar Piatt, (Photo 12) W9HZC. He talked of the Midwest Homebrewers and QRP group going to flea markets and setting up a table showing built gear but nothing is for sale. The purpose is to talk with people about amateur radio, especially the kids. A receiver is set up to hear space shuttle activity when available. He spoke of a pathologist who got into radio building after visiting. The group hosts a field event, 1DIJ (one day in July), which is similar to Field Day. Kids are invited to come to meetings.

The hardest part of teaching any group is to keep the enthusiasm up. One has to keep coming up with ways to get people to return because they enjoy it. Dar mentioned he found a kid interested in radio but with little backing to get anything. Dar gave him a radio and taught him to get his license. He is now an active amateur and wondered about the radio. Dar told him to give it to a kid like himself and keep the hobby going. Dar feels everyone should have a radio they can give to someone like that kid.

The last talk of the day was "Zero Cost QRP" by David Cripe, NMØS. (Picture earlier) He started a story about you being stranded in a house with the streets having aliens and Zombies as the only individuals out there. People had fled the area and you wanted to contact them via radio. How would you do it? The idea was to build a transceiver in 12 hours with parts on hand. The first idea was to search the house for old phones, radios, TVs, and smoke detectors. Pine sap or beeswax can be used for rosin. Telephones often have lead blocks for weight, so solder is there. A screwdriver with wire wrapped around it can serve as a soldering iron. It does need heat, perhaps from the kitchen stove. Look at TVs and radios for through-hole parts. Many transistors, resistors and capacitors have been around a long time and will continue to be. Wall transformers could be used for power. Also any lamp cords speaker cable or extension cords can be used for building an antenna. Any fishing pole can get an antenna up.

In reality, this was a story. But in Haiti, Japan, New Zealand, Katrina and, I am sure Joplin, amateurs have stepped in. One needs the right equipment, the proper mental preparation and realizes you cannot count on power equipment to be available. But maybe you can find what is needed for zero cost QRP.

During the meeting each speaker is given a plaque for their talk. At the end of the session, a plaque was awarded to Darrel Swenson, KØAWB, for his involvement in the building session. In the Wacky Key Contest, Richard Bennett, KCØPET, won with a fishing pole key. In the Homebrew Contest, the Best-in-Show went to Dennis Burton, N5DRB, for his handcrafted keys. QRPer of the Year went to Paul Smith, NØNBD, for his work in kitting the various 4SQRP kits and getting them out to customers. Finally, the grand prize of the meeting, an Elecraft KX-1, plus extras (antenna tuner, the two extra bands, and Black Widow paddle) went to Raymond McNally, Jr, N5SEZ.

For dinner, several of us went out to a local restaurant, of which there are many, and then stopped in at the Titanic special events station. Mainly, we walked around

Photo 14—The boys in the (ham) band provide a little musical entertainment.

looking at the various equipment being used for this station. Joe Eisenberg, KØNEB, from our group, sat down at one of the seats and made several contacts for the Titanic station (Photo 13). That evening was spent looking at home-brew equipment, demonstrations and socializing. The final event of the evening was the QRP musical session (Photo 14). Sunday morning was check-out time.

I hope everyone has a good summer. I now have my SS-40 kit to build and will be putting in at least two more antennas in my garage attic (you know-subdivision restrictions). When the house was built, a two inch PVC pipe was put into the wall from the garage attic to the basement, where my new room is. I will have no trouble getting antenna wires into my shack. I also put in a ground rod prior to the cement basement floor being poured so should be in business.

If you have anything for future columns, please get it to me. Thanks much.

—72, Tim, WB9NLZ

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QRP ARCI 50th Anniversary Celebration

John Burnley—NUØV

QRP ARCI is 50 years old this year, and to celebrate the club is holding a yearlong operating event. That's correct—beginning this past January, the club call K6JSS has been activated from a different state each week and will continue until December 31, 2011. Check the QRP ARCI site for more details on the operating schedule. The response for operating was so positive; the decision was made to allow multiple operators to operate during the week with activities coordinated by a point of contact (POC). At the time of this article, there are only eight states left needing a POC. Volunteer needs will be posted on the various QRP forums—if you would like to help out and coordinate your state please contact me at nu0v@arrl.net.

The club will be recognizing operators for various levels of states worked, and do not worry if you have missed some. Plans are now being made for opportunities to catch up although details are not finalized. While there is not an official count, station trustee Jim Stafford W4QO estimates (at the time this note was prepared in early June) contact counts are near 4,000—a few states had close to 500 contacts. Check out the bands and look for K6JSS/*x*, where "*x*" will be the call area of the state activated that week 0-9).

Do you need certain states for WAS? Do you need states on certain bands or modes? This is an excellent opportunity to log those needed states. Turn on your rigs and start listening for K6JSS!

—72/73, John NUØV

Update from the QRP ARCI President

The year 2011 will mark QRP ARCI's fiftieth or Golden Anniversary. In 1961, we started out as a 100 watt club interested in reducing QRM, and have transitioned into a group of operators, hikers, builders/experimenters, and contesters that pursue this great activity at five watts or less.

One way the club will mark this anniversary is to activate the club call in all 50 states, Puerto Rico and the District of Columbia throughout 2011. A QRP ARCI member/volunteer will be assigned one week during the year in which they can use the club call, K6JSS from their location. We encourage them to operate with K6JSS with as many modes and as often as possible during their assigned week. A special Worked All States certificate will be issued to all that qualify.

The club needs volunteers to make this happen. We need one member/volunteer from each state, Puerto Rico and the District of Columbia. The member will agree to operate using K6JSS during their assigned week. John Burnley, NUØV has volunteered to coordinate this effort for the club. He will work with volunteers to assign a week for their area and insure that the club trustee is notified. If you wish to volunteer, send an email to John at nu0v@arrl.net. This email address is being protected from spam bots, you need Javascript enabled to view it . He needs your call and location plus any weeks during 2011 that are not good for you.

I hope to see all 50 states plus Puerto Rico and the District of Columbia on the air during 2011.

—72, Ken Evans, W4DU
President, QRP ARCI

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The Plumbing Defined Radio

David Cripe—NMØS

ai9e_qrp@yahoo.com

While much of the technology of today's amateur radio can be traced back to its origins, a review of the history of radio uncovers many evolutionary dead-ends. One of the more unique of these was the "Acoustic Wave Filter" which made its first and only published appearance in the August, 1928 *QST*. Literally, a "Plumbing-Defined Radio," it was an audio band-pass filter made of lengths of water pipe.

This presentation will examine this technology, its probable origins, its performance and shortcomings, and how it might be brought up-to-date for use in a modern ham shack.

Introduction

Many years ago, I happened to acquire a pile of *QST* magazines from the 1920s, and was struck by the illustration on the cover of the August 1928 issue. Depicting a strange construction of pipes, it was labeled 'The Acoustic Wave Filter', and glowingly promised "Unparalleled Selectivity!" The article, by Roland Bourne, 1ANA [1], described what amounted to be an audio band pass, CW filter based on coupled acoustic resonators.

As a QRP fanatic, I find the early years of QST to be fertile sources of ideas for simple, effective radio circuitry. The amateurs of that time were often forced to improvise around the limited equipment of the day, and many of the circuits used at the dawn of our hobby can be applied to our present-day low-powered radio equipment. Here, however, was a filter technology that was not only low-powered, it was not even electrical! While I have dabbled with virtually every type of filter, this was something completely new to me. To discover this unique design in the midst of a 1920s magazine was quite unexpected, and immediately seized my imagination. This was a mystery worth pursuing.

Background

Despite the fact that this was the first and only time an article on acoustic filtering appeared in the pages of *QST*, its development did not occur in isolation. To understand the likely influences behind the genesis of Bourne's acoustic wave filter, one must explore the history of filter theory which had its origins some forty years previously, in the field of telephony.

Figure 1—Cover, August 1928 *QST*.

As the telephone became a common household fixture, and runs of telephone wires extended between cities, it was noticed that the acoustic quality and sound fidelity of telephone signals degraded over long distances. The brilliant mathematical physicist Oliver Heaviside deduced that this was due to the nature of telephone lines being a transmission line having its characteristic impedance mismatched to the load impedance of the microphone and telephone receiver. In his 1887 paper [2], he proposed that loading coils could be periodically placed along the length of the telephone lines to effectively increase their impedance, allowing their loads to create the proper match to flatten their frequency response.

The idea was not put into practice until 1900, when George Campbell, a Bell Telephone scientist successfully verified the principle. Campbell's subsequent insight that the frequency response of a circuit could be shaped by mimicking the effects of mismatched transmission line, formed the basis of his 1917 patent [3], which set the groundwork for "Electric Wave Filter" theory. By forming circuits of cascaded inductors and capacitors, high-pass, low-pass, band-pass and band-reject filters with predictable performance could be designed according to his equations.

While the new science of electrical engineering was being established, the science of acoustics being developed as well. The German physicist Helmholtz had made studies of acoustically resonant structures, inventing the Helmholtz resonator, a thin-necked bottle that resonated at a specific audio frequency. Helmholz' work was expanded upon by Bell Telephone scientist Warren Mason, researching ways to improve sound quality of telephone handsets, describing acoustic filters fabricated of sections of tubing that formed acoustic analogues of electrical capacitors and inductors. His comprehensive analysis was published in his paper in the *Bell Systems Journal* in April 1927 [4].

As the decade of the 1920s drew to a close, amateur radio operators were faced with CW bands that were congested with signals, and no adequate solution for separating these signals had yet been devised. Superheterodyne receivers were still in their infancy, and Lamb was not to publish his pioneering work on single-signal crystal filters until 1933 [5]. Campbell's invention of the Electric Wave Filter was, by this point, familiar to the readers of *QST* [6], but was discussed primarily as a means to remove AC hum from power supplies. Amateurs had a pressing need for a narrow-band audio filter to improve CW reception. Lack of commercially available electronic components made construction of a passive, L-C audio filter impractical. Enter Roland Bourne.

The Acoustic Wave Filter

The article "Acoustic Wave Filters and Audio Frequency Selectivity" appeared as the cover article of the August, 1928 *QST*. The author, Roland B. Bourne, 1ANA, was employed at the Maxim Silencer Company, in Hartford Connecticut. The Maxim name should require no introduction to any ham, as Hiram Percy Maxim, 1AW, was the founder of the ARRL. Maxim, an eclectic and prolific inventor, had founded the company to manufacture one of his more lucrative inventions, an

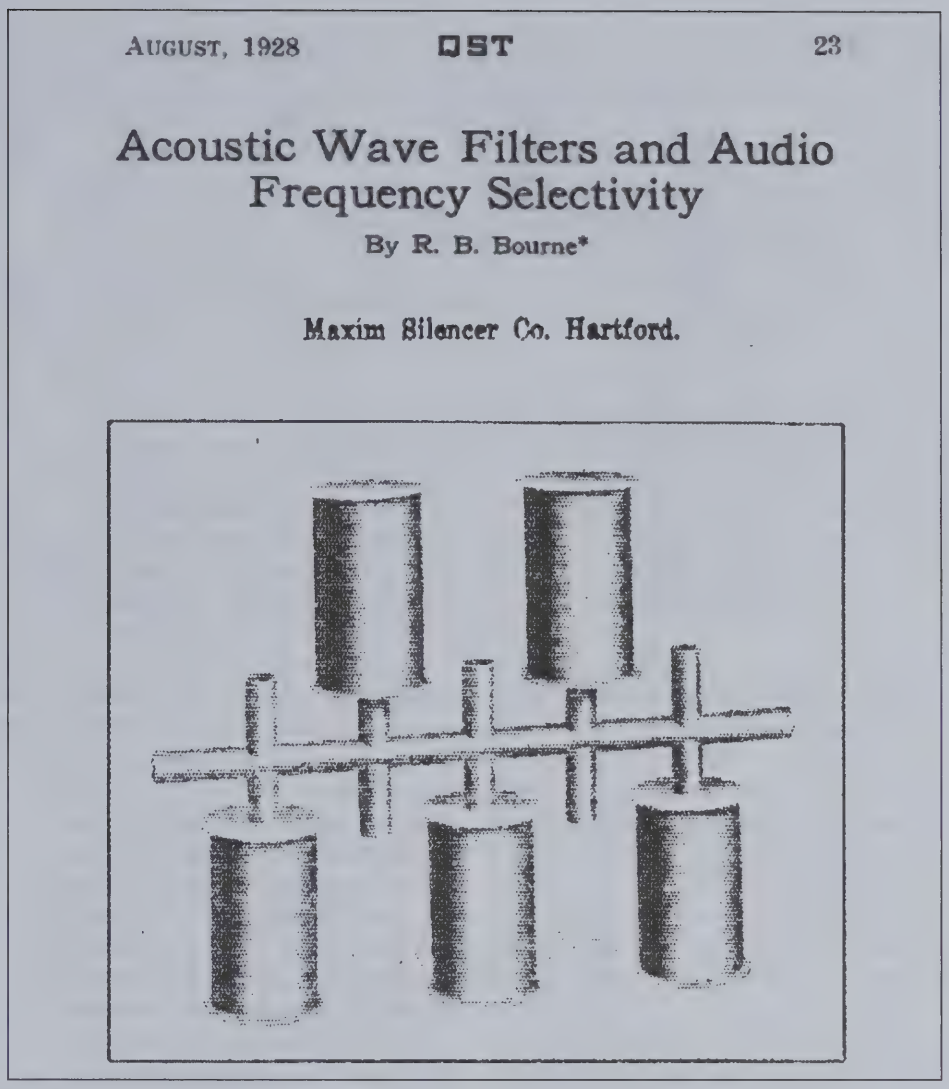
Figure 2—Roland Bourne 1ANA

acoustic noise reducer, which when attached to a firearm was known as a "silencer" and to an automobile, was known as a "muffler."

Bourne was a fairly prolific inventor in his own right, and frequent contributor to *QST*. He contributed his radio expertise to pioneering the field of radio-controlled model airplanes, and during the ham-radio-silence of World War II, wrote to describe optical communication techniques. In his latter years he served as the curator of the ARRL Museum.

In the 1920s, Bourne was a research engineer working in the field of acoustics as they related to noise suppression. Maxim's firearm silencer and automobile muffler both served the purpose of attempting to reduce noise emitted from a gunshot, or an internal combustion engine, respectively. Acoustically, both noise sources are essentially impulse functions, with high amplitudes and short durations. The function of the noise-suppressor was to spread the impulse energy out over time in a manner less disturbing to the listener. Structurally, Maxim's firearm silencer was formed from a steel tube filled with dished, steel disks, perforated in the center by a hole just large enough for the passage of the bullet. The alternating large and small diameter passages would have served as the acoustic equivalent of an electrical low-pass-filter.

As engineers, both Maxim and Bourne would have been motivated to remain current on the latest research in the acoustic field. To a scientist active in both the radio and acoustic fields, Mason's paper would have certainly provided the spark of inspiration to merge the two fields to create an acoustic band-pass filter for amateur CW. Bourne cites Mason's paper in his article, from which he distilled simplified equations to be better understood by the average *QST* reader.



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Acoustic Wave Filters and Audio Frequency Selectivity

By R. B. Bourne*

Maxim Silencer Co. Hartford.

Figure 3—Detail of the Acoustic Wave Filter.

The filter he described consisted of lengths of copper water pipe soldered together to form a five-resonator bandpass filter. The filter was driven by a headphone element, and rubber tubing and headset from a Dictaphone coupled its outputs to the ears of the user. To the home craftsman of the 1920s, none of these parts or construction techniques would have been unusual, and certainly easier than building custom inductors and capacitors to construct an L-C audio filter.

Bourne simplified Mason's equations for the case where the lengths of the tubing were much smaller that a wavelength of the sound to be filtered, they could be modeled as ideal capacitors and inductors. Per Bourne's article, an acoustic capacitance is formed by a section of tubing closed at one end, and has its value determined by the following equation:

$$C_a = \frac{V_0}{A^2 \times \rho}$$

where:

V_0 = volume of tubing, cm^3
A = speed of sound of air, 34,000 cm/sec, and
ρ = density of air, 1.2 mg/cm^3 at sea level.

An acoustic inductance, on the other hand, is formed by a section of tubing open

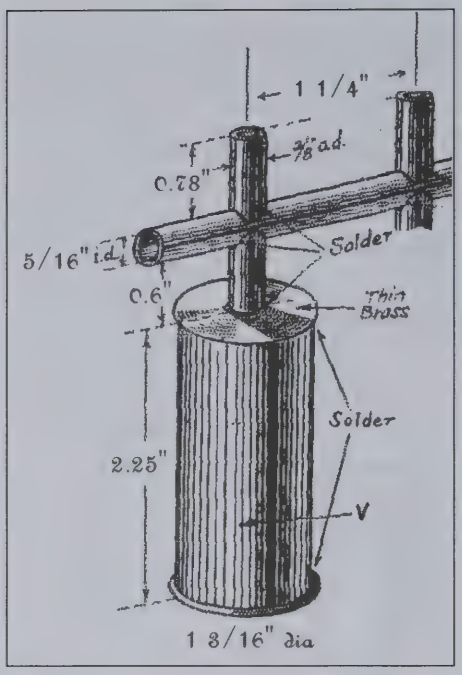

Figure 4—Construction details of a single resonator.

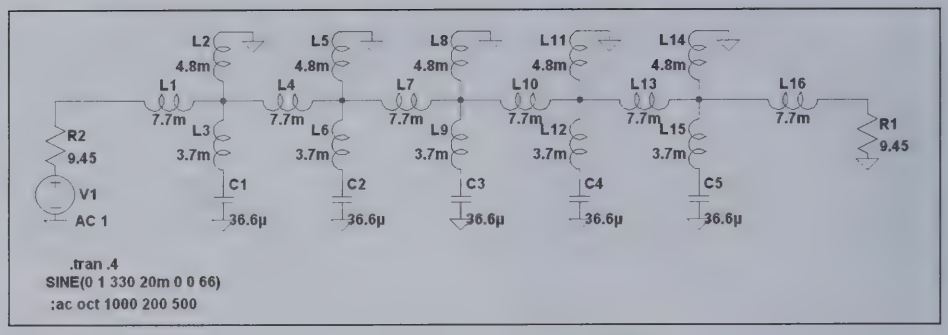

Figure 5—Electrical equivalent circuit of the Bourne filter.

at both ends. Its value is determined by the following equation:

$$L_a = \frac{l \times \rho}{S}$$

where:

l = length of tubing, cm, and
S = cross-sectional area of tubing, cm^2.

An acoustic ohm is defined as the impedance required to produce a pressure of 1 dyne/cm^2 against a volume flow of 1 cm^3/sec.

Bourne's filter can be considered to be a five-pole nodal-inductor coupled band-pass filter. The five resonators each consist of a section of small-diameter tubing branching off of the main transmission line, feeding into a large diameter cavity. An open section of small-diameter tubing branches off the main transmission line in the opposite direction. This resonator is the equivalent of a series L-C, shunted by an L.

With the equations above for calculating the values of acoustic inductance and capacitance from the dimensions of the tubing sections, it is possible to create an equivalent electrical circuit that can be analyzed using filter analysis software. This circuit is shown in Figure 5. Each section of the filter is identical, so one can consider it to be similar to the Cohn crystal filter popular in amateur radio equipment. One parameter that is missing from Bourne's filter model is the effective value of termination resistance provided by the headphone driver and rubber earpiece tubing at each end of the filter. For sake of this analysis we give Bourne the benefit of the doubt, and select the value of terminating resistance giving the best filter performance, 9.45 acoustic ohms.

To analyze the performance of the filter, the free-ware CAD tool LTSPICE was used. Available from www.linear.com, it permits circuit simulation, and has become a favorite tool of many circuit designers. Using the frequency-domain circuit analysis tool in LTSPICE, the amplitude and phase response of this circuit was calculated. The results are shown in Figure 6.

It can be seen that the amplitude response (solid line) of this filter is centered at 330 Hz, with an 80 Hz bandwidth, providing good agreement with the performance Bourne had calculated. It has extremely sharp stop-band attenuation, with considerable ripple within the pass band. The phase response (dashed line) however, is very non-linear. How does this translate to actual performance?

In the weeks after I had discoved this article, I decided to build one of these for myself. After a week of acquiring and cutting tubing, and soldering with a HIGH wattage iron, it was done. I hooked it to my vintage Hallicrafters receiver and tuned in 80 meters…

…and I found the filter to be nearly unusable! True, it was very sharp, but it rang so badly that all the noise present in the 80 meter band dissolved into a near-continuous tone. Using the transient analysis capability of LTSPICE to simulate the

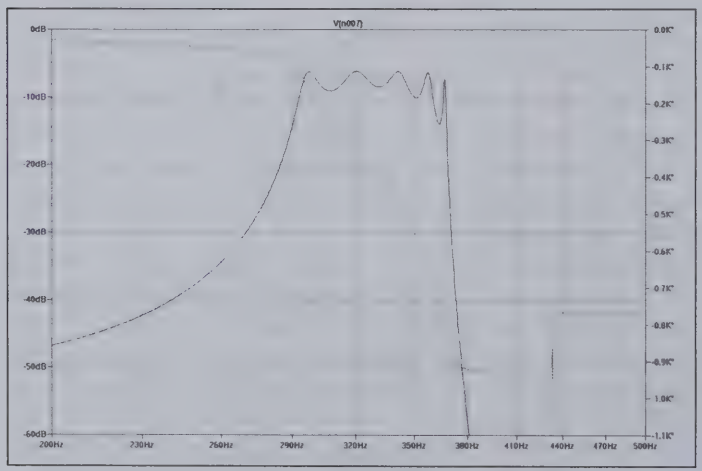

Figure 6—Frequency response of Bourne's filter.

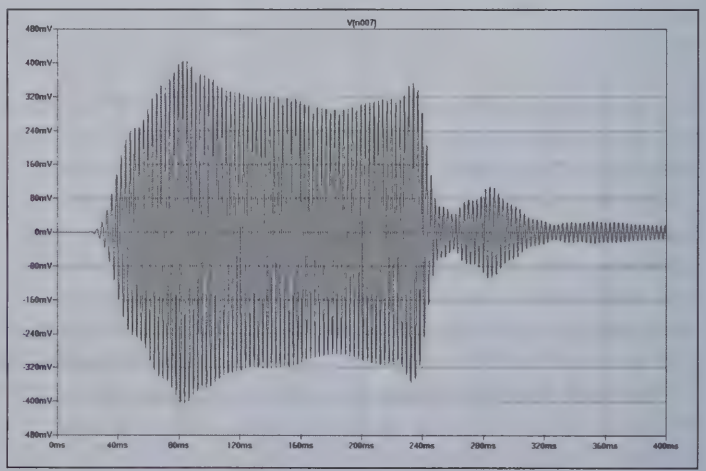

Figure 7—Poor CW waveform of a 200 ms dot.

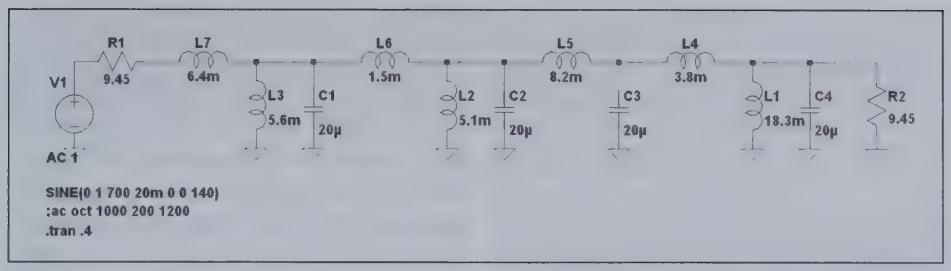

Figure 8—Equivalent schematic of an acoustic wave Bessel filter.

Figure 9—Four-resonator Bessel band-pass filter pictorial.

circuit, we see just what happens to the envelope of a 200 ms CW 'dot'. Figure 7 shows the disappointing result.

The poor performance of this filter in no way invalidates the technique of acoustic wave filtering, just the particular design that Bourne published. With more than eighty years of hindsight on our side, one wonders how modern filter design technique can be applied to improve on Bourne's plumber's nightmare.

In the years leading up to World War II, scientists involved in design of radar electronics developed classes of filters specifically to handle the pulsed radar waveforms without distortion. It was discovered that there was an additional dimension to filter performance besides its amplitude response. Although not always appreciated, the filter's phase response is also critically important to the performance of a narrow-band filter [7].

The reason for this is, while a steady CW tone consists of a single frequency, if this frequency is pulsed by keying, there are sidebands introduced. A string of CW dots, for example, can be considered to be a carrier that is 100% modulated by a square wave signal at the dot pulse rate. To the carrier are added two sidebands at plus and minus the dot rate frequency, as well as those corresponding to the third, fifth, and seventh harmonics, etc. For the CW pulse to pass through the filter with its envelope undistorted, each of these sidebands frequencies must pass through simultaneously. This condition only occurs when the phase response of the filter is a straight line within the frequencies of the passband. Viewing the phase response of the filter in Figure 5, we see the very lumpy, distorted phase response. The poor impulse response of the filter is the direct result of this.

Updating the Acoustic Wave Filter

It is unfortunate that the performance of the Bourne acoustic wave filter was so poor, as it likely doomed the concept to an untimely extinction. It begs the question of just how good a "plumbing defined" filter could be. With the benefit of eighty years of hindsight, and modern filter design tools, we may attempt to guess.

Filters designed to pass pulsed waveforms without ringing have a particular, rounded shape within their passband frequency response, and a linear phase response. They are referred to as Bessel filters. The design of these filters is not easily done without computers, but software is readily available. With the host of freeware design tools available, we can design and model an updated version of Bourne's Acoustic Wave Filter without even picking up a hacksaw.

To begin with, we shall move the center frequency of the filter from the 330 Hz to 700 Hz to follow the practice of modern receiver design. The audio frequency of 700 Hz is reputed to be where human hearing is most acute, so we may take advantage of this. We will also widen the bandwidth of the filter to 200 Hz, which is on par with a good narrow CW filter. For sake of consistency, we will assume the acous-

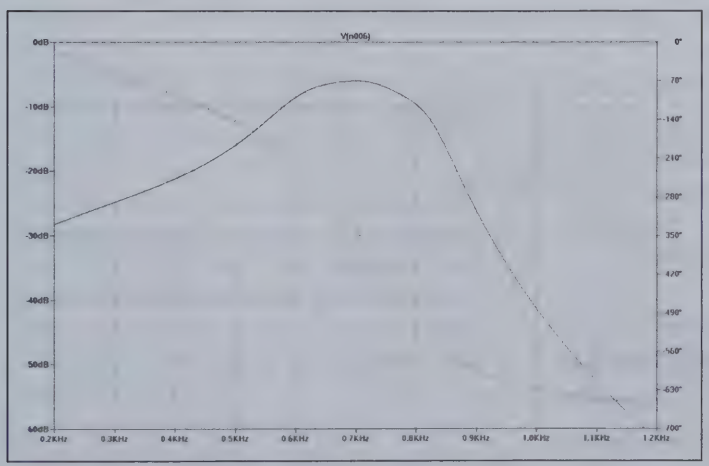

Figure 10—Bessel band-pass filter frequency response.

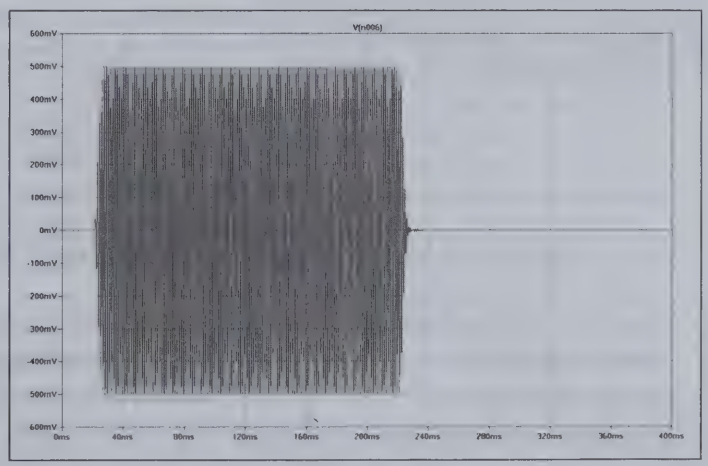

Figure 11—Bessel band-pass filter impulse response.

tic impedances of the source and load remain at 9.45 acoustic ohms.

To design this filter, we may choose one of the many free-ware filter design packages available. The one selected here was Elsie, available from www.tonnesoftware.com and included with the 2011 *ARRL Handbook*. Entering the desired parameters and attempting to design a five pole filter, we receive an error report—evidently, designing a five-resonator Bessel filter with a fractional bandwidth of 0.28 requires use of negative inductors! However, a four-resonator filter is possible, with its schematic depicted in Figure 8. (Notice one of the resonators becomes a capacitor).

Entering this circuit into LTSPICE, we can plot the frequency response, shown here in Figure 10. Notice the very rounded peak to the amplitude response, very characteristic of the Bessel filter. Notice also the phase response (dashed line) which is very flat compared to the Bourne filter.

The impressive result comes when the new filter's impulse response is analyzed. When a 200 ms pulse of 700 Hz audio is applied, the LTSPICE results are shown in Figure 11. The filter response shows almost no ringing or distortion of its envelope. This is near-ideal performance.

I have not built one of the improved filters. The availability of PVC pipe and adhesives would make its construction much faster and cheaper than one of copper. The low cost, efficient, earbud audio transducer would be a logical choice to replace the original headphone element. A condenser mic element could replace the original rubber tubing, and allow subsequent stages of audio amplification. There is no reason that performance of the new and improved filter could not be on par with that of current QRP radio designs.

The question remains, however, of what the impedances presented by audio drivers and earpiece tubing (or microphone) actually are. While performance of the filter can accommodate an almost 4:1 range in either source or termination impedance, with little affect on performance, being able to design the filter around their actual values would yield the best result. Some research and further modeling is necessary.

Conclusion

The "Acoustic Wave Filter" of Roland Bourne was a clever, yet flawed idea for CW filtering. The concept could have allowed a radio hobbyist with simple tools to construct an audio CW filter with performance on par with a much more complex device. Perhaps if hams of 80 years ago had devoted the development effort into Acoustic Wave filters as they did into crystal filters, its shortcomings would have been resolved, and this idea would have been in more widespread use. However, with modern design tools, perhaps an updated Acoustic Wave filter, and "Plumbing Defined Radios" may yet come into more widespread use.

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QRPp from J-Land

Dennis Markell—N1IMW dennis_m_markell@uhc.com

Who's working 1/2 of 1 watt from Japan? Well, if you copy JQ2UOZ anytime soon, you will be working one of Japan's leading 500 mW operators, Akihiro Akai. By day, Mr. Akai is a technical writer in the field of biochemical and organic chemistry. By night, JQ2UOZ operates CW from the City of Nagoya, scouring the ionosphere for his prized North American DX contacts.

In 1975 at the age of 10, Mr. Akai was first licensed in Japan and he has a natural ear for code. When I asked him how he learned code, JQ2UOX responded: "I was absorbed in radio and enjoyed listening to CW QSOs. Thus I memorized the code without effort." Regarding basic operating principals, JQ2UOX was without an Elmer growing up: "I learned operating principles from magazines for novice amateur radio operators". By age 13, Mr. Akai was working field day with local hams and, "I enjoyed bicycle mobile using a 2 meter band FM transceiver and my father's car battery".

The first station owned and operated by JQ2UOZ was a Kenwood TS-520 X. The Japanese version of the TS-520x was a 10 watt rig and JQ2UOZ fed a wire dipole cut for forty meters and was set 7 meters about ground. Other rigs came along and Mr. Akai did work QRO at 50 watts from time to time.

In 1999 the QRP bug bit Mr. Akai. "At first, my QRP was only a challenge for me. Then I found it interesting and became enthusiastic about QRP, especially QRPp DX ing at 500 mW." Like many QRP enthusiasts, JQ2UOZ started out with specially-designed mono band QRP gear: "In 1999-2001, my main QRPp rig was Mizuho P-21DX. It is a VXO-type CW transceiver and its output power is 500 mW."

Mr. Akai is a recognized contester, but it is propagation that captures his imagination: "In Particular, I am interested in radio-wave propagation at QRPp powers. I have experienced a lot of amazing and surprising radio-wave propagations at QRPp 500 mW.

What countries has JQ2UOX worked at 500 mW? Consider this, having just moved into a new apartment, using a temporary dipole, the JQ2UOZ logbook reflects the following sample entries this past May, 2011:

The JQ2UOZ "antenna farm" consists of a temporary dipole at his apartment.

EIØCZ (Ireland): May 3, 2011; 1204UTC; 17M Band CW (His antenna: Dipole)

5N6/YL2SW (Nigeria): May 3, 2011; 2034UTC; 17M Band CW (His antenna: Dipole)

GWØETF (Wales): May 6, 2011; 1906UTC; 17M Band CW (His antenna: Doublet)

Not only are these 500 mW contacts remarkable, consider Mr. Akai's lowest level contact ever, 50 milliwatts into New Zealand, a mere 10,000 km from the JQ2UOZ operating position.

Contesting is tops on the list for JQ2UOZ. In 2008 CQ WW CW contest, he placed number 1 in Japan and 4th worldwide with 226 QSOs; 24 Zones and 61 DX entities. As we all know, this was a sunspot minimum era. A long path contact was worked during the 2009 CQ Worldwide CW contest: "There were zero sunspots and 15 meters propagation was poor—surprisingly and unexpectedly I was able to work Zone 5, W3LPL, at an unusual time (0532 UTC).The signal of W3LPL was very strong like a local station and S9 on my meter!" This 2009 CQ WW CW also showed strong results for Mr. Akai: 163 QSOs, 26 zones and 45 entities.

What's next for JQ2UOX? Perhaps Elmering his son, "I hope he will learn the Morse code." Above all else, working the miracle of milliwatt operations remains the passion of Mr. Akai. "Why do such low power signals propagate to such remote areas without significant energy loss? Is nature a magician?" ●●

A Mizuho P-21DX has served as Mr. Akai's main QRPp rig.

Mark ur Calendars for these QRP ARCI Contests

10-12 September 2011	**End of Summer VHF Contest**
15-16 October 2011	**Fall QSO Party**
1 December 2011	**Top Band Sprint**
18 December 2011	**Holiday Spirits Homebrew Sprint**

Charlie the Tuner: An Antenna Preselector and Matcher

Chris Trask—N7ZWY christrask@earthlink.net

Antennas are essential components of a radio communications system. It is well known that proper coupling of the antenna to a transmitter determines the overall power efficiency of the transmitting antenna system, but what is less known is that proper coupling of the antenna to a receiver is an essential element in the overall antenna noise temperature seen by the receiver, which subsequently plays a major role in the overall performance of the communications receiver system.

The purpose of this paper is to present a brief overview of receiver antenna systems, follwed by a detailed discussion of the nature and consequences of mismatches within the antenna system, and finally details of the design of an antenna preselector and matching unit that is suitable for both short wave listening (SWL) and radio amateur QRP applications.

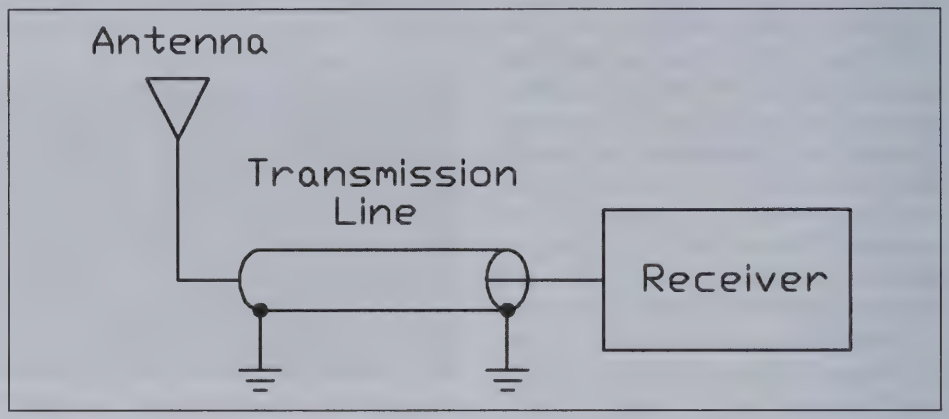


Figure 1—Receiver antenna system.

The Receiver Antenna System

As shown in Figure 1, a receiving antenna system consists of three basic components, being the antenna, the transmission line, and the receiver. Each of these items has a characteristic impedance, and the overall quality of the system is very much dependent on how well these three impedances are matched to each other.

The characteristic impedance of the transmission line is generally the least flexible, and is is most often, if not always a fixed quantity that is designated as Z_0. The input impedance of the receiver is easily controlled by design, and is usually in the order of 50 ohms, and the use of 50-ohm coaxial transmission line pretty much eliminates any concerns of mismatch at this point in the system.

Antennas, however, are the Achille's Heel of the system as their terminal impedances can vary over a wide range. This is especially true in high frequency (HF) radio amateur and SWL applications, where a single antenna is used over a wide frequency range. The mismatch of the antenna and transmission line is very often overlooked by even serious hobbyists, the consequence of which is a greatly increased antenna noise temperature, which results in the loss of low-level signals which become buried in the noise due to the increased noise that is a consequence of the mismatch.

What's All This VSWR Stuff, Anyhow?

If a load is not matched to a transmission line properly, a portion of the power is reflected back to the source, and a pattern of voltage (and current) standing waves will result. The ratio of the maximum voltage on the line to the minimum value is defined as the voltage standing wave ratio, or VSWR, and is often known in radio

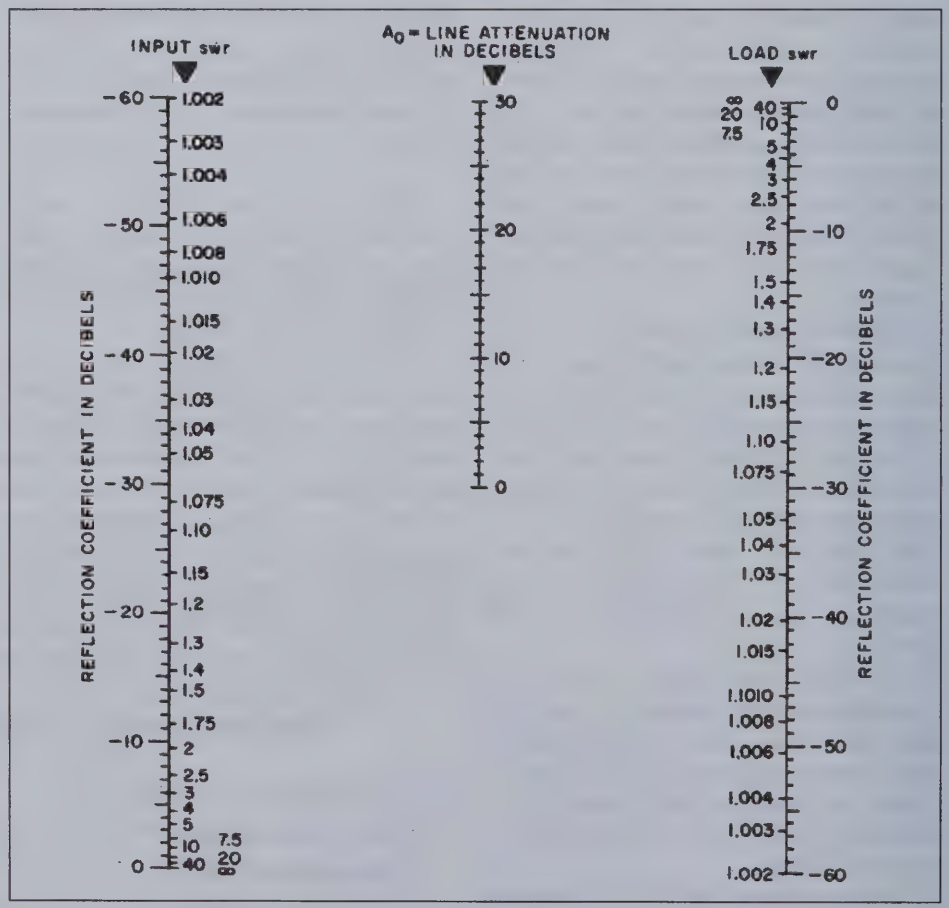


Figure 2—Line Attenuation and Voltage Reflection Coefficient for low SWR (from Ref. 3).

amateur literature by the abbreviation SWR [1, 2]. The SWR is related to the forward and reverse voltages by way of [1, 2]:

$$SWR = \frac{V_F + V_R}{V_F - V_R} = \frac{1+k}{1-k} \quad (1)$$

where VF is the "forward voltage", V_R is the "reverse voltage", and k is the reflection coefficient, which is related to SWR by [2]:

$$k = \frac{1-SWR}{1+SWR} \quad (2)$$

The terms "forward voltage" and "reverse voltage" refer to the line voltages of the power propagating from the source to the load and reflected by the load back to the source, respectively. This is an alternative to measuring the maximum and minimum line voltages. An additional term of interest is the return loss, RL, measured in dB, which is also a measure of the quality of the matching of a transmission line and a load, which is related to SWR by way of:

$$RL = 20\log\left(\frac{SWR-1}{SWR+1}\right) = 20\log\left(\frac{1}{k}\right) \quad (3)$$

and which is related to the reflection coefficient k by way of [1, 3]:

$$k = 10^{RL/20} \quad (4)$$

If the terminal impedance of the antenna is known, the reflection coefficient k can be determined by way of [3]:

$$k = \sqrt{\frac{(R_{ANT} - Z_O)^2 + X_{ANT}^2}{(R_{ANT} + Z_O)^2 + X_{ANT}^2}} \quad (5)$$

where R_{ANT} and X_{ANT} are the real and imaginary parts of the antenna terminal impedance, respectively.

The consequence of a mismatch between the antenna and the transmission line, as well as any between the transmission line and the receiver, is that there will be a loss of signal power, for which the term "insertion loss" (IL) is applied. When the SWR is known, the IL can be determined by way of [3]:

$$IL = 10\log\left(\frac{(SWR+1)^2}{4\,SWR}\right) \quad (6a)$$

and it may also be determined from the reflection coefficient k [1, 2, 4]:

$$IL = 10\log\left(\frac{1}{1-k^2}\right) \quad (6b)$$

In addition to the losses caused bypower being reflected by mismatches, there are also losses in the transmission line itself due to the mismatches. For a losses transmission line, the loss A_0 due to the mismatches at the antenna and receiver ends is [3]:

$$A_0 = -\left|\frac{|IL_{ANT}| - |IL_{RCVR}|}{2}\right| \quad (7)$$

where IL_{ANT} and IL_{RCVR} are the insertion losses due to impedance mismatches at the antenna and receiver, respectively. This loss can be determined graphicly by way of the charts of Figure 2 (low SWR) and Figure 3 (high SWR). To use these charts, simply trace a line from the antenna SWR along the left bar to the receiver SWR on the right bar, then read the A_0 loss where the line crosses the bar in the centre. And as if that were not enough, there is additional dissipation loss in the transmission line due to load mismatch, designated as $[A - A_0]$, which can be determined by [3]:

$$[A - A_0] = \frac{SWR_{ANT} - \frac{1}{SWR_{ANT}}}{SWR_{RCVR} - \frac{1}{SWR_{RCVR}}} \quad (8)$$

where SWR_{ANT} and SWR_{RCVR} are the SWR at the antenna and receiver ends of the transmission line, respectively. This loss can easily be determined by way of the chart of Figure 4.

Here, draw a straight line beginning on the bar at the far right, using the value for A_0 determined from Eq. 7, Fig. 3, or Fig. 4. From there draw the line through the load SWR found on the diagonal bar, then continue to the bar on the left, finally reading $[A - A_0]$ where the line intersects the

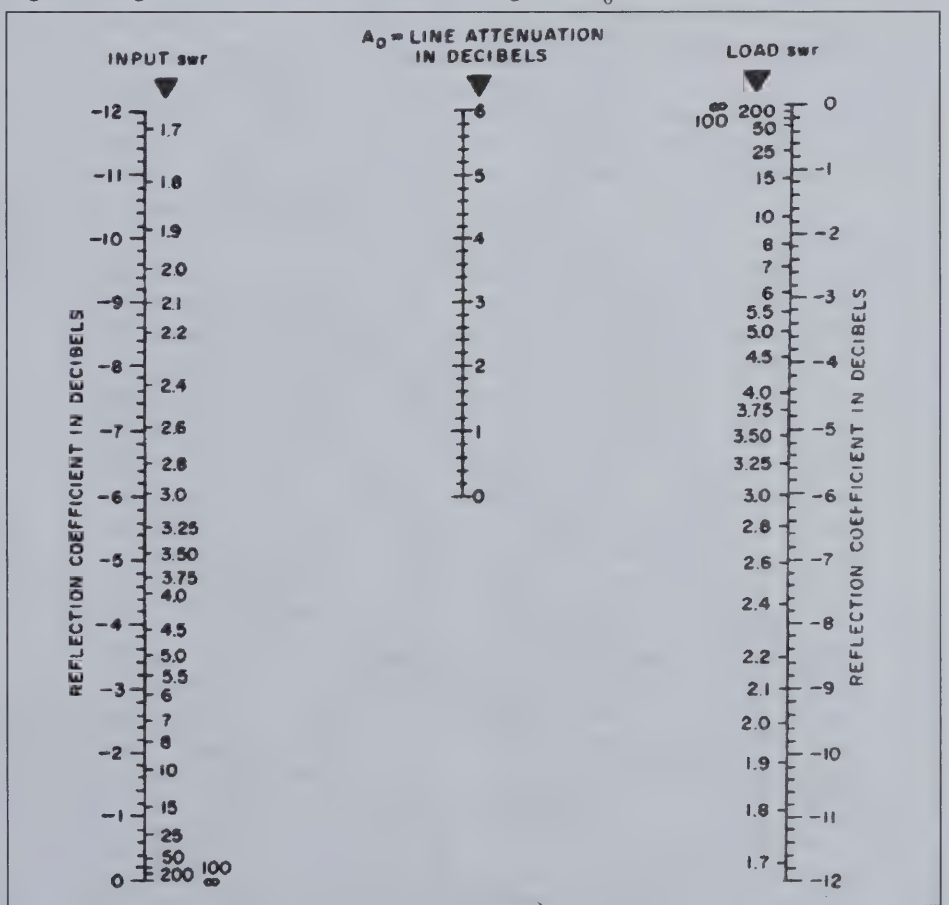


Figure 3—Line Attenuation and Voltage Reflection Coefficient for High SWR (from Ref. 3)

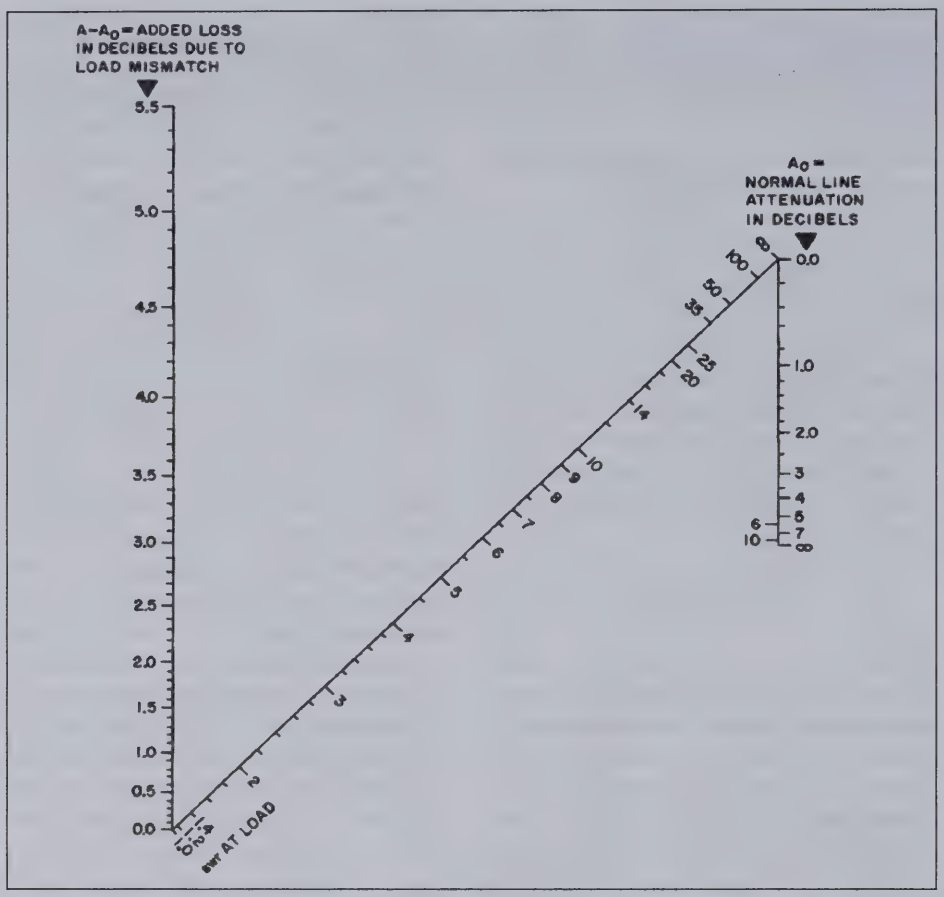


Figure 4—Additional transmission line loss due to load mismatch (from Ref. 3).

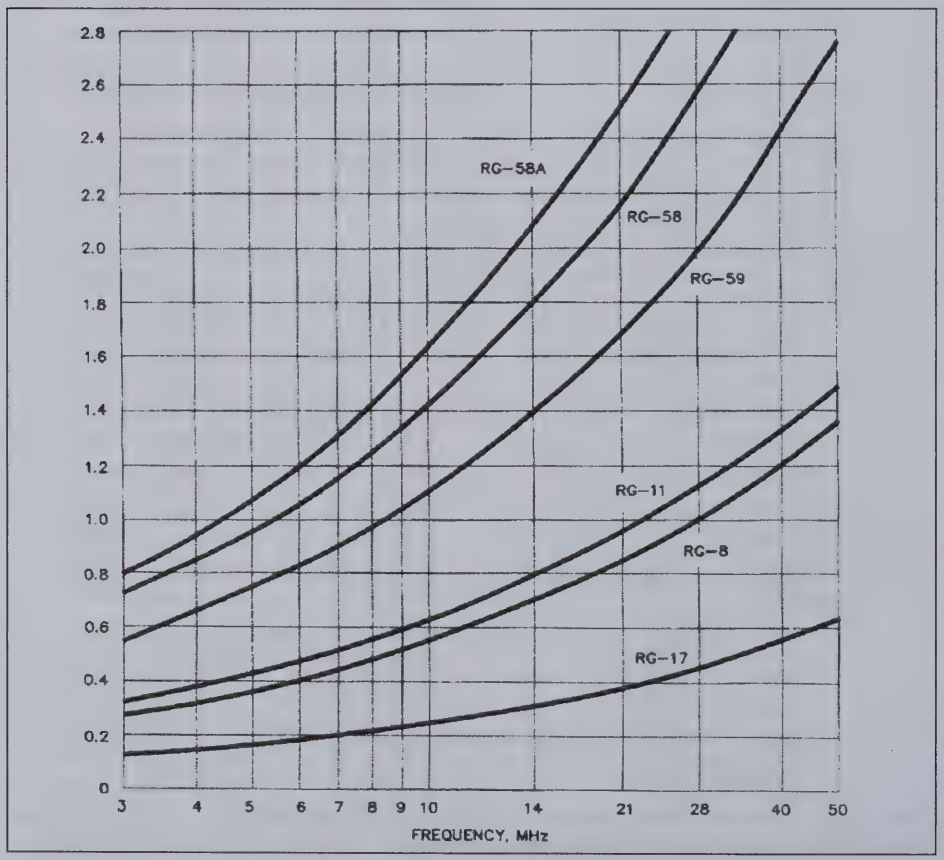


Figure 5—Attenuation in dB per hundred feet for various coaxial cables (from Ref. 4).

left bar.

And finally there is the loss IL_{TL} of the transmission line itself, which is most easily determined by way of manufacturer's data, such as that shown in the chart of Figure 5 [4]. With all this known, the total loss from the antenna, through the transmission line, then to the receiver becomes:

$$LOSS = IL_{ANT} + IL_{RCVR} + A_0 + \\ + [A + A_0] + IL_{TL} \quad (9)$$

The first four terms of Eq. 9 are a direct result of impedance mismatches at the antenna and receiver ends of the transmission line, and the last term is due to finite resistance and conductance losses of the transmission line itself.

The overall effect of a mismatched antenna is exactly the same as having a perfectly matched antenna with an attenuator of the value determined in Eq. 9 inserted, the consequences being elevated antenna noise temperature (meaning increased NF) and the potential loss of low-level signals.

You can easily see from all this that there are serious consequences to mismatching the antenna to the transmission line, and you can also see why many of us prefer to have a low noise amplifier (LNA) mounted right at the antenna.

Antenna Matching Techniques

Matching an antenna to a transmitter or receiver through a transmission line is no simple matter, and there are more methods of accomplishing this than you may be comfortable knowing. For narrow-band situations such as a spectrum set aside for radio amateur or short wave broadcasting (SWBC), a dedicated antenna with some degree of impedance matching is very practical. What little mismatch remains in such situations is readily alleviated with a matching unit at the users station.

Many such matching units are readily available commercially, though they tend to be intended for transmitter applications and are capable of handling power levels up to, and sometimes exceeding 1 kW. As a consequence, they tend to be a bit costly and far exceed the needs of most hobbyists.

Most of these transmitting antenna matchers fall into two basic categories, the first being that of a π matching network and the second being a TEE matching network, shown in Figure 6 and Figure 7,

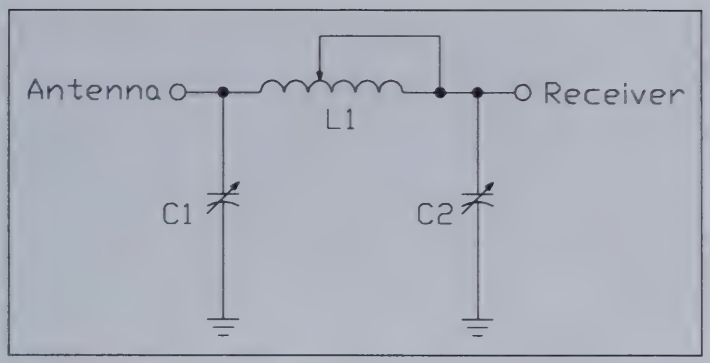


Figure 6—Basic π matching network.

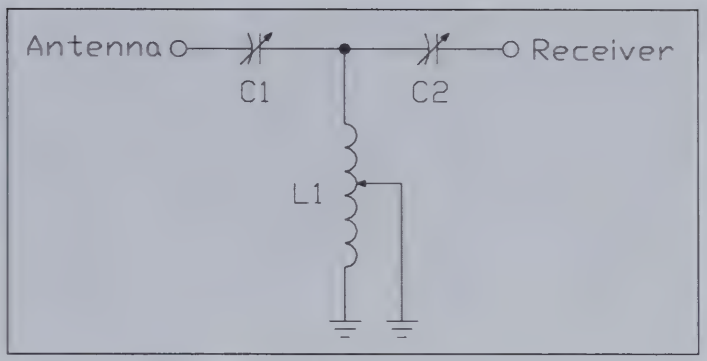


Figure 7—Basic TEE matching network.

respectively.

The π matching network of Fig. 6 is by far the most popular, consisting of a pair of variable capacitors across the input and output and a variable inductor between them, usually of the rotary type though many less expensive designs will use a fixed inductor with switch-selected taps. The popularity of the π matching network has a lot to due with the fact that it is basically a low-pass topology, and in being so it helps to reduce harmonics from the transmitter. For a receiver application, this topology gives little if any relief from the intrusion of medium wave (MW) broadcast signals in the input stages of the receiver, which may result in harmonics and other IMD products interfering with desired SWBC signals.

The TEE matching network of Fig. 7 is less popular, probably owing to the fact that it is a high-pass network and therefore does not offer much, if any reduction of transmitter harmonics. For a receiver application, this type of matching network provides the needed protection from MW broadcast signals that is not provided by the π matching network of Fig. 6.

One popular commercial antenna matching network of this type has a very serious design flaw. On at least one model, the control shafts of the variable capacitors are passed through an insulated bushing on the front panel to the control knob without any insulated coupling and shaft grounding, so that the operator's fingertips are an inch or so away from very high RF voltages. These units, rated for 1 kW power levels, are actually a safety hazard and would never pass UL certification.

An additional form of antenna matching network is shown in Figure 8. Though not commonly seen on commercial products, this form can be readily found in the ARRL handbooks and other publications. Basically, it is nothing more than a parallel-tuned resonant tank with the inductor being tapped, actually using it as an autotransformer. In Fig. 8, the configuration shown is for situations where the antenna impedance is higher than the receiver impedance.

For situations where the antenna impedance is lower than the receiver impedance, the input and output connections are simply reversed. A matching network of this type functions as a preselector as well as an impedance matcher, and therefore provides protection from MW broadcast signals as well as reduction of transmitter harmonics.

A Practical Antenna Preselector/ Matcher

A practical approach to the design of a preselector/matcher is shown in the schematic of Figure 9. Here, the continuously variable inductor of Fig. 8 is replaced with a tapped inductor, and by using a 2-pole 11-throw (2P11T) rotary switch, impedance ratios varying from 0.7:1 to 1.4:1 can be selected without the need of reversing the input and output terminals.

Having five impedance ratios either side of unity provides a reasonable degree of matching control. The inductance of the tapped inductor L1 is chosen so that in

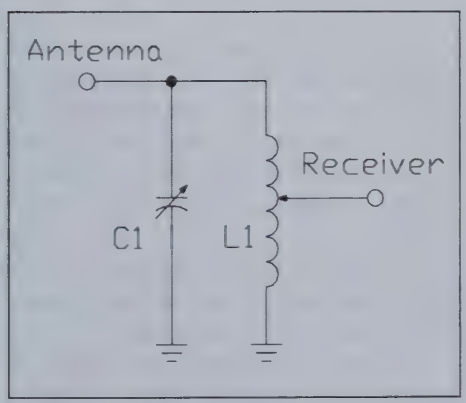


Figure 8—Basic preselector/matcher.

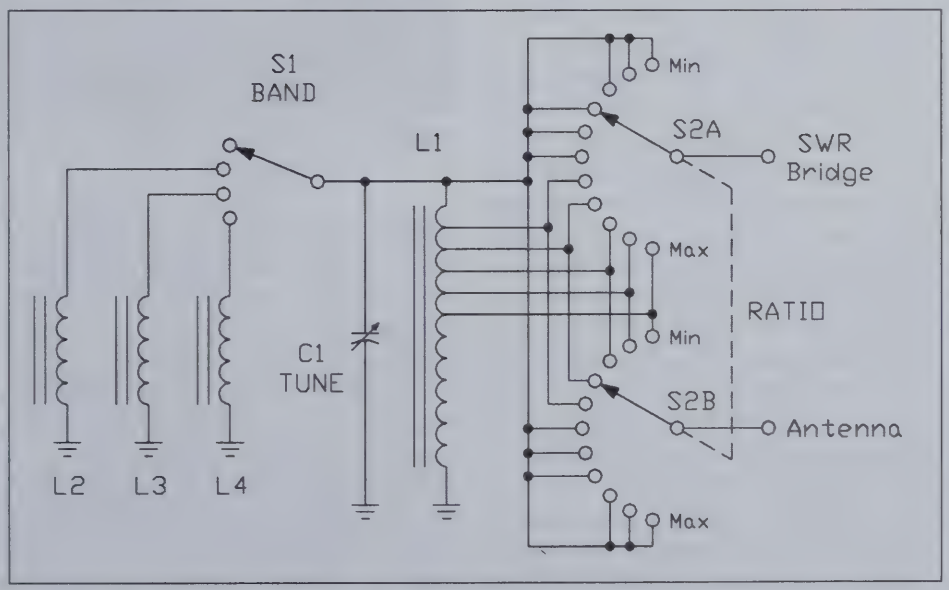


Figure 9—Preselector/matcher schematic.

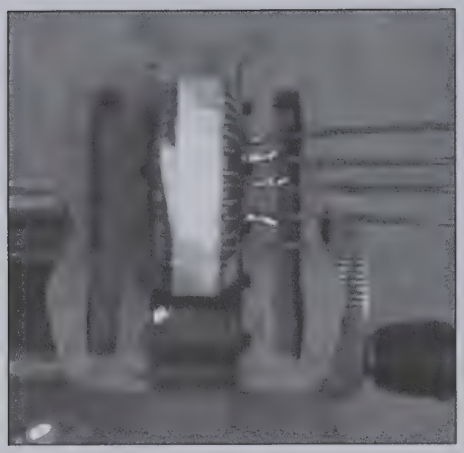
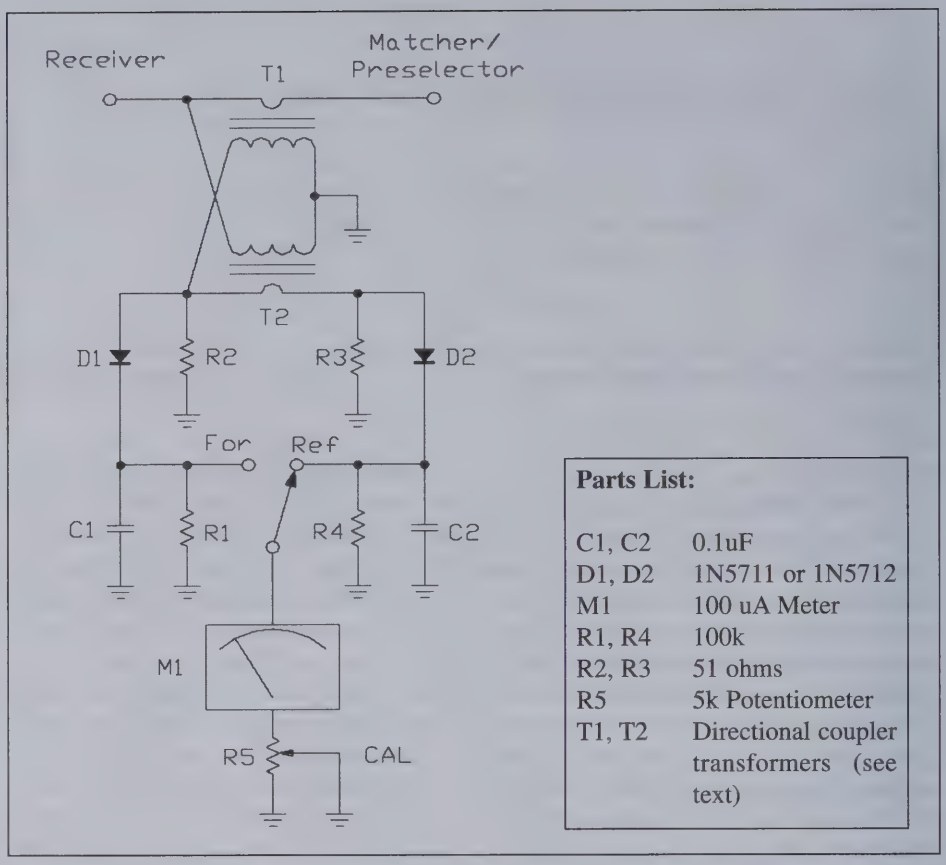


Figure 10—Tapped inductor L1 construction details.



Parts List:	
C1, C2	0.1uF
D1, D2	1N5711 or 1N5712
M1	100 uA Meter
R1, R4	100k
R2, R3	51 ohms
R5	5k Potentiometer
T1, T2	Directional coupler transformers (see text)

Figure 11—SWR bridge schematic and Parts List.

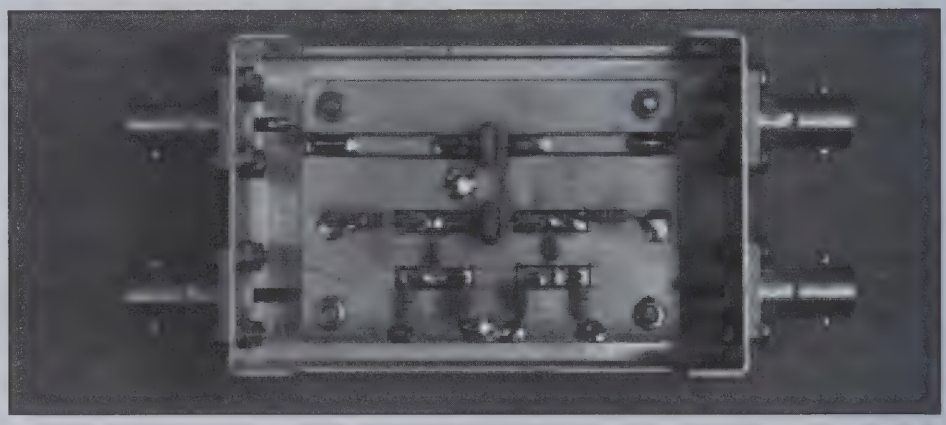


Figure 12—A typical SWR bridge, in a connectorized box for general test use.

combination with tuning capacitor C1 the preselector/matcher can be tuned to the lowest desired frequency. The inductance of the tapped inductor L1 is chosen so that in parallel with inductors L2, L3, and L4 the full range of frequencies can be tuned in any number of desired bands. The variation of tuning capacitor C1 will dictate the number of bands required.

For the prototype a 350 pF variable capacitor was used for C1. Inductor and autotransformer L1 was made with 40 turns of #22 enameled wire on an Amidon T102-6 toroid core, the turns then held in place with a layer of Scotch 27 glass cloth tape, as shown in Fig. 10. Four taps were made at turns 38, 36, 34, and 32. This provided an inductance of around 18 uH, which resulted in a minimum tuned frequency of just over 2 MHz. Fixed inductors of 5.6 uH, 1.2 uH, and 0.47 uH were used for L2, L3, and L4, respectively.

To make the design a bit more versatile, an SWR bridge is included. There are probably as many variations in this essential piece of radio equipment as there are people making them. The circuit shown in the schematic of Figure 11 is representative of most of the passive designs that you will find, consisting of a directional coupler (T1 and T2), a pair of level detectors, a selector switch, meter movement, and calibration control. Some versions make use of a pair of directional couplers, which provides better isolation between the forward and reverse voltage ports.

Transformers T1 and T2 are constructed by winding anywhere from four to eight turns of small gauge wire on a T25-6 toroid core. A large diameter wire is passed through the toroid, and heavily insulated wire will help keep everything in place. The assembly shown in Figure 12 is a typical assembly, this one being connectorized for use as test bench equipment.

The prototype for the tuner was constructed in an aluminum and steel enclosure, and is shown in Figure 13 and Figure 14. The large knob on the far right is the tuning control, to which a 1:7 reduction drive is included for making the tuining easier as the tuning Q can be quite sharp in the higher bands. The smaller knob immediately to the left along the top is the ratio control S2, and the next to the left is the band select swtch S1. The small knob to the left of the tuning control along the bottom is the SWR bridge sensitivity control. Finally, a DPDT centre-off toggle toggle switch is used for the SWR bridge FOR-REV switch. SO-239 connectors are used on the rear panel as they are more secure and robust than BNC connectors.

The meter movement just happens to have a logarithmic scale and was found in a local junk yard.

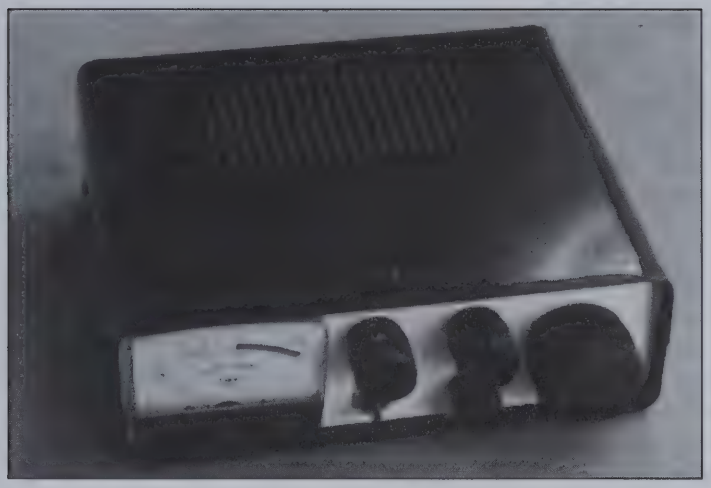


Figure 13—Preselector/matcher prototype (front view).

Figure 14—Preselector/matcher prototype (rear view).

Closing Remarks

The need for properly matching an antenna to a feedline cannot be emphasized enough, and the consequences of failing to do so have been presented clearly in the beginning of this paper. In addition, a highly versatile and cost-effective unit for matching an antenna and feedline to a receiver or preamplifier has been described. Using this antenna matcher does not in any way preclude the need for making a reasonable effort to at least match the real part of the the antenna impedance to the feedline at the antenna terminals. But, when doing so in conjuction with a matching unit such as described herein the antenna to feedline matching is somewhat less critical.

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VHF QRP: Working Further With QRP

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Effective communication at VHF depends on high effective radiated power (EIRP) and good receive sensitivity. I discussed this in my Winter 2010 *QRP Quarterly* VHF column. When we try to work long distances on VHF we are operating at or near the noise floor, so every dB counts, particularly with QRP. While it is true that a single decibel (dB) is generally the smallest increment that can be detected by the human ear, and hence one is tempted to ignore improvements at or below a dB, after having ignored three or four single dB improvements this way, it is easy to have thrown away half one's power with the repeated claim that the improvement is not noticeable. It is easy to make big changes and note the improvement, it requires more commitment to make the several small changes necessary and note the cumulative improvement of several such changes. Attention to detail is critical for success at the VHF bands.

All too often, a newbie to QRP VHF will hook up his brand new FT-817 to a loop antenna on a short TV mast fed with RG58U and get on. Or, migrating from FM, he will try his hand at operating weak signals with his vertical antenna. While this can be lots of fun, particularly during a sporadic-E opening on 6M, it only goes a short way to demonstrating what VHF weak signal work is really capable of. This user will hear other locals open the band before he can hear anything and close the band long after he can hear any signals. He will check into the weak signal activity nights and find out that he cannot hear stations on two meters that are more than 30 or 40 miles away, even though they can hear him fine. He will hear the locals working stations out to 200 miles or more on a "dead band" consistently, even though he can't hear the other end of the conversation. He will hear the locals complete meteor scatter contacts on weekend mornings before he even hears a single ping from the other station. He calls stations on SSB that he can hear and they don't come back. With these experiences he becomes discouraged and concludes that the VHF bands can be fun, but it really takes1.5 kW output, a stack of beams fed with hard line and cryogenically cooled preamp to really use the VHF bands. He looks for his fun in ham radio elsewhere. He doesn't have to, it is possible to get a lot more performance and enjoyment at VHF out of our stations without spending a fortune.

Antenna	Gain (dBi) (in free space)
Loop	1
Dipole	2.1
Moxon	6
3 element Yagi	8
6 element Yagi	11
Long Yagi (~ 2λ)	15

Table 1—Nominal free space gain for common VHF antennas.

I am trying to show in this column how to best improve your basic station so that you can work further. We will start with the antennas, feed line and getting your antenna up in the air. Next month we will go into other items that can be improved.

Antennas

It is no secret that the best thing you can do to improve your station at a reasonable cost is to improve your antenna system, particularly at VHF. At VHF it pays off double, both on receive and on transmit. Improving your antenna also means feeding it with low loss feed line and getting it up where it can do some good. I will discuss those two topics later in the column.

Look at the progression of gain in going from a simple loop antenna to a dipole to longer beams shown in Table 1. While long beams may be impractical for most, if not all of us at 6M, they are manageable by many at 2M, and manageable by almost everyone at 432 MHz.

Antennas can be easily homebrewed by nearly anyone and it is cost effective to do so. Skip the loop. Dipoles can be made with the same techniques as at HF. With shorter dipoles at VHF, larger diameter conductors can be used, thereby gaining a bit of bandwidth. Still, if you have room for a loop or a dipole, chances are you also have room for a Moxon, a simple two element Yagi, or even a 3 element Yagi. When it comes to antennas be aggressive.

W4RNL, N2MH, and DK7ZB all have designs for easily reproducible Moxon antennas. The W4RNL site requires registration with Antennex, which you may or may not wish to do, but L. B. was a pioneer in getting widespread acceptance for the Moxon, and his site has a wealth of information on the Moxon and its variants. The N2MH site has detailed plans for a 6M Moxon that can be built with the 3/4-inch aluminum angle that is commonly available at large home improvement stores such as Lowes, Menards, and Home Depot, as well as your local hardware stores associated with True Value or Ace. The cost for fabricating such a beam is $40 to $50 depending on the price of aluminum, which depends in turn on the price of energy. Shopping at a metal supplier may yield better prices and a known alloy, but the home improvement store aluminum angle is adequate and commonly available. Construction is straight forward, and most dimensions are non- critical. The 2M, 220 MHz, and 432 MHz versions can be built from 1/8 inch bronze weld rod at a cost less than $5.

http://www.n2mh.net/moxon.htm
http://www.qsl.net/d/dk7zb/

There are few commercial Moxons available, but the PAR SM50 is worth noting. It has a unique lightweight construction and is a portable antenna, easily dissembled and carried in a pack. The cost is in the $100 range, so it is twice the cost of a homebuilt job, but it is tough to beat for lightweight antennas. I use one in the rover and it stands up well to 75 mph Interstate speeds, although it does less well with low lying tree branches. The parts are readily available to fix it, and it comes apart easily

I use the WA5VJB Yagi designs for longer Yagis. These antennas are easy to build, inexpensive, can be made from readily obtainable materials, and require little or no tuning. Design information is available in the 2010 and 2011 *ARRL Handbooks*, as well as on the web:

http://www.wa5vjb.com/yagi-pdf/cheapyagi.pdf

I use 1/8 inch bronze weld rod for the elements and #6 or #8 copper wire for the

driven element. Avoid aluminum weld rod for the elements, it tends to work harden and become brittle over time. The boom is a straight piece of wood, 1/2 x 1-1/2 inches for 2M and 222 MHz, 3/4 by 3/4 inch for the higher bands. Paint or varnish the boom for protection against the weather. I use these antennas in the rover and while they survive the 75 mph interstate test, on occasion the elements require some straightening and adjustment.

The WA5VJB Yagi designs stop at modest boom lengths. For Yagis with longer boom lengths and more gain, as well as for 50 MHz Yagis, the DK7ZB designs are solid, and while not as easy to homebrew as the WA5VJB designs, they are still straightforward to build:

http://www.qsl.net/d/dk7zb/

These antennas should require little, if any, tuning.

YU1AW also has some designs for excellent Yagis on his web page, but they are essentially a collection of free space element lengths and spacings that require a bit more translation into actual construction data than do the WA5VJB or DK7ZB Yagis. Still, they are excellent performers, with good clean patterns.

http://www.yu7ef.com/

For the ham moving up from a loop or dipole to a small directional antenna, there is 5 to 10 dB available at relatively low cost. This can mean the difference between being heard and worked by the other station or being buried in the noise. It can easily mean a difference of 50 to 100 miles in range. Of course, one needs a support for the beam and a way to turn it. Options for those will be discussed later in the article.

Improve the feed line

You already know that improving the antenna system is probably the best bang for the buck upgrade you can do for your QRP station. At VHF it pays off double, both on better receive and more effective radiated power on transmit. At VHF feed line loss is also important, particularly important on receive, as the feed line loss appears directly as increased system noise figure, which in turn limits the minimum signal that you can receive. At HF, external noise dominates and feedline loss is not so important for receive.

Good feed line does not come cheap, but it is a worthwhile investment to make, and considering the investment the typical QRPer has in his station, even the best feedline is a small fraction of the total shack investment. Many hams think nothing of spending $1000 for a rig, but balk at the extra $50 or $100 investment in low loss feedline. This is truly false economy.

The tables contain four representative feed lines RG58A/U, an inexpensive feed line with mediocre performance, RG8X, a feed line commonly used at HF, RG-213, a longtime workhorse low loss feed line, LMR-400 a low loss feed line for VHF/UHF uses, and RG-6, an inexpensive widely available cable TV coax, that at 75 ohms is not used much by hams, but has a low loss at the lower VHF bands.

It is best to think long and hard at what kind of feed line to use. Cost and loss are the two main considerations. Decide on an acceptable loss and a price you are willing to pay and try to match the two up. This should be done while considering the losses and cost of the entire system. As a rule of thumb, feed line losses less than 0.5 dB are probably not worth pursuing vigorously unless the cost of the feed line is low, and feed line losses above 1 dB should be addressed if the financial resources are available. Within these guidelines, it is a good idea to buy the best quality feed line you can afford. As most of us started out with what feed line is available locally or what we had available on hand, our feed line losses are probably not optimized. In reviewing the performance of your VHF/UHF station, start with the feed line.

Good quality connectors and adapters should be used on the feed line. Name brands are to be preferred over no name connectors, even if they are more expensive. Amphenol and Kings are two US manufacturers of reliable and high quality connectors. Consider crimp on connectors, they are no less reliable than the soldered kinds and are much easier to install, particularly for N connectors. The hit, of course, is in the cost of the crimper and dies, but if one can be borrowed, or the expense shared among several locals, crimping is the way to go.

The common UHF series of connectors, the PL-259 and SO-239, can be used up to 222 MHz with no problems. They can also be used at 432 MHz, but loss starts to become problematic there. The recommended solution is to use N connectors or BNC connectors at 432 MHz and above. For non critical applications, or where few connectors and adapters are used, it is really a tossup at 432 MHz as to whether to use good quality UHF, N, or BNC connectors. If you have a lot of connectors in the cable runs, like in phasing harnesses, or are doing really low noise applications like EME, then the N and BNC are worth installing. I use a mixture of UHF, BNC, and N connectors on the rover UHF on 6M, BNC and UHF on 2M, UHF, BNC and N on 222 MHZ, and N and BNC on 432 MHz. I carry a couple of zip lock bags full of adapters with me when I rove. If you are using RG6U, install common crimp F connectors and use adapters to BNC, UHF or N connectors. It is possible to obtain these connectors for RG6, but they are not common and are more expensive than the adapters.

As an example of possible feed line tradeoffs, consider my rover. I have feed line runs of 20 feet to 25 feet depending on the band. I started out feeding my 6M and 2M antennas with RG8X because that is what I had on hand. On 6M, the loss is roughly 0.43 dB with the RG8X and on 2M the loss is 0.74 dB. Well, the losses on 6M are tolerable, but the losses on 2M are certainly in the gray area and can be

Band (MHz)	RG58A/U	RG8X	RG213/U	LMR400	LMR600	RG6/U (75 Ω)
28	1.2	0.8	0.5	0.3	0.2	0.4
50	1.6	1.1	0.7	0.4	0.3	0.6
144	3.1	1.9	1.3	0.7	0.5	1.2
222		2.3	1.6	0.9	0.6	1.5
432		3.4	2.4	1.3	0.84	2.1
902			3.8	1.9	1.3	3.1
1296			4.9	2.3	1.5	
Cost for 50 ft	**$26**	**$34**	**$70**	**$55**	**$146**	**$18**

Table 2—Line loss (dB) in 50 ft of commonly available feedlines at VHF/UHF bands. (Entries end when loss exceeds 3 dB; you don't really want to lose more than half your power do you?)

improved. Shortly after I started roving, I was given a large quantity of RG213 and I immediately swapped out the feed lines on 6M and 2M. This reduced the 6M loss to 0.29 dB or so, which would probably not be worth the expense if I had to have purchased the RG213, but the 2M loss came down to 0.48 dB, which means I can spend money elsewhere to improve performance on 2M. I also used the RG-213 for my 222 MHz and 432 MHz antennas, again because it was available, with corresponding losses of 0.64 dB on 222 MHz and 0.97 dB on 432 MHz. These losses could both be lower, but they are not terrible and I am willing to accept the higher loss because the feed line was free. I have plans to replace these runs with LMR400, but I can use my resources to look elsewhere for station improvement for the time being. Now I sheepishly admit to using a 20 ft run of the free RG213 at 1296 MHz, which gives me a line loss of 2 dB, which compounds the already mediocre noise figure of my TS-2000X there, and reduces my EIRP by a third, so replacing my 1296 MHz feed line with LMR400 or LMR600 is at the top of the list of improvements to be done to the rover before the UHF contest.

Let's say our ham friend with the FT817 and loop fed with RG58, having previously replaced the 6M loop with a Moxon to get 5 dB improvement, now replaces the RG58 with LMR400. An additional 1.2 dB is obtained.

Increase Antenna Height

The most common day-to-day propagation mode at VHF is troposcatter. Troposcatter intensity and range is a function of the scatter angle, which in turn is a function of the radiation angle, which in turn is a function of antenna height. In addition, raising one's antenna can get it further from noise sources, thereby decreasing your noise level and increasing your received signal to noise ratio. Raising the antenna above any absorptive surroundings helps, but is not always feasible.

Consider W5JAY, located in Ft. Smith Arkansas. His QRP station on 2 meters, a FT-817 to a 6 Element WA5VJB mounted at 10 ft above his patio is probably a typical beginners VHF QRP Installation. There is a super station at KBØHH 240 miles away in Oklahoma. KBØHH runs 1.5 kW out, has a 4X4 Yagi Array at 75 ft fed with hardline and a good low noise receiver. Jay can hear KBØHH above the noise most of the time, but KBØHH has a lot of problems hearing Jay. What can Jay do? Table JRD-2 shows the effects of raising his antenna. As can be seen from the table, raising the antenna to 30 feet from 10 feet results in a 14 dB improvement in signal to noise ratio! With this improvement, W5JAY should be Q5 at KBØHH, if not strong, with the increase in height. In this specific case, there is no further improvement above 30 ft because both stations already optimally fill the common scattering volume, but if they were further apart, going higher would help more.

Now these figures will vary according to distance between stations, closer stations having less additional gain with height, and further ones having more. It will also vary with terrain, and the time of year. Troposcatter has lots of QSB and the numbers in the table are valid 50% of the time. Half the time it can be up to 7 dB worse that these numbers and half the time it can be 7 dB better. There are similar variations with season; with late summer and early fall being better than the dead of winter.

What is the best way to get more height? Telescoping Rohn slip up masts are a good solution with 30 ft ones available for $80. These require guys, but these can usually be installed without too much problem and will accommodate modest VHF antennas. Ten foot sections of TV masting are available from Radio Shack, they may need to ship to your store, but that shipping is free. These are not telescoping, but swaged to fit into each other. They are a bit less expensive than the slip up masts.

You can turn the antenna by hand, a la Armstrong, but this will soon grow old. An inexpensive TV type rotator can be added for less than $100 that will turn these modest sized VHF antennas. By the time the cheap rotor breaks you will be ready to move up in antenna size and rotor capacity.

In any case, you should strive to get your antenna at least a half wave above ground, or the nearest conducting surface. This may be a stretch for some urban dwellers on 6M, where a half wave is 20 ft or so, but it should be in the reach of most on 2M and higher. Consider the use of your roof or chimney as a base to get your antenna higher with little additional investment.

Putting it All Together on Two

Lets see what that guy with an FT817 feeding a loop at 144 MHz with RG58A/U can do if he implements the suggestions above (Table 4). As you can see, there is a lot of gain to be had with these modest improvements. The cost to achieve that gain is not trivial, but it is not prohibitive either and it can be done incrementally. It is less than the cost of a new QRO rig or an amplifier. The key is to know where to invest and to homebrew the antennas.

Next Time

Next time we will discuss the improvements that addng a preamp, narrowing bandwidth, using alternate modes, using standard operating practices, increasing the output power to 10 watts (the VHF/UHF QRP maximum), and managing the DC power to the rig. ●●

Antenna Height at W5JAY (ft)	Path Loss for smooth 240 mile path (W5JAY to KBØHH) at 144 MHz (in dB)	Signal to noise ratio in 2.5 kHz bandwidth @ KBØHH (in dB)	Signal to noise ratio in 2.5 kHz bandwidth @W5JAY (in dB)
10	–210.7	–6	14
20	–203	–1	21
30	–196	8	28
40	–196	8	28
50	–196	8	28

Table 3—Signal to noise ratio improvement for raising antenna.

Improvement	Gain over Baseline	Cost
Go to 6 element WA5VJB beam from loop	10 dB	$ 25
Go to LMR-400 feedline from RG58A/U	2.3 dB	$ 55
Raise antenna to 30 ft from 10 ft, add rotator	14 dB	$ 180
Total	**26.3 dB**	**$ 260**

Table 4—Gain available with improvements in feedline, antenna, and height.

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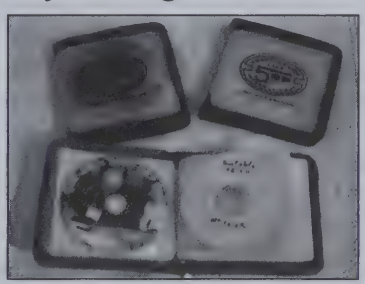

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A Confidence-Building Project for Newbie Builders: Part 2

Pete Juliano—N6QW radioguy90@hotmail.com

Welcome back to our project, new builders. By now, I hope that you have completed the receiver we discussed in Part 1 of this article and have had the time to use it to listen on 40 meters. If you have, you are no doubt pleased by some of the stations you have hauled in and excited about finishing the transceiver. If your receiver isn't quite working just yet, don't give up. Usually the problem is quite simple. It just requires going over what you have done in some detail and making sure that all connections are solid and that parts have not failed as a result of some miswiring. You should attack the problem stage by stage, starting with the audio output and proceeding back through the receiver. You will find the problem in due time.

Now let's look at the transmitter portion of our transceiver. You might want to refer back to Figure 1 in Part 1. There you will see that the VXO you have already completed provides one input to the transmit mixer. The other input frequency will be supplied by a crystal oscillator that is a part of the SA602/612 mixer IC. This is followed by a band pass filter, mixer, driver chain, final amplifier and low pass output filter. Looking at Figure 1, it might appear that the transmitter is a smaller project than the receiver. Nevertheless, a lot of thought went into the transmitter stages shown in Figure 1 as there are several "gotcha's" such as frequency instability, (like drift & chirp), key clicks, harmonic output exceeding FCC standards, buzz on the signal if operated from an AC supply. The output waveform must avoid these problems if the transmit signal is to be clean and have a pleasant sound. Thus, no corner cutting should be employed relative to bypassing, stage gain, isolation and shielding, method of keying and so on.

Now, let's get started by laying out the transmitter board. My layout of the completed transmitter board is shown in Figure 16. If you are following this layout, you will need a second piece of 3 in. by 4.5 in. single sided copper vector board. Notice that there are three other function blocks installed on this board besides the stages forming the transmitter chain. These other functions include the TR Switch and Keyer, the output Low Pass Filter and the Receiver RF amplifier. Make sure when you lay out this board that there is a space allocation for these other functional blocks.

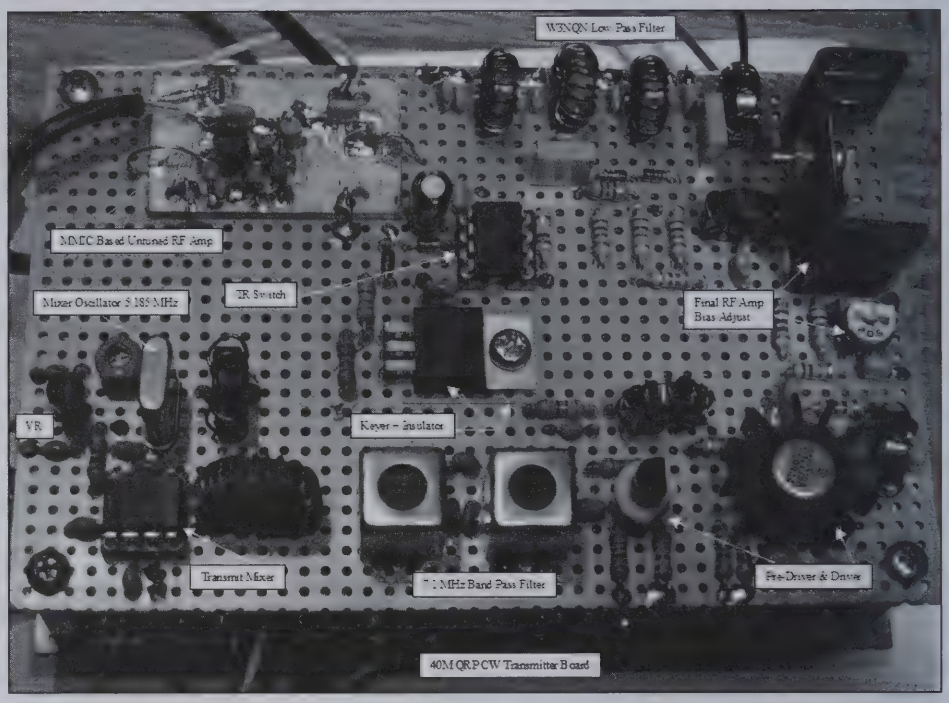


Figure 16—Completed transmitter board.

The Transmitter Mixer circuit, shown in Figure 17, comes directly from the Phillips data sheet for the SA602/612 and employs the balanced tuned output option. This is one more measure to assure that the output of the mixer is tuned to the difference of the VXO (12.228 MHz) and the Mixer frequency of 5.185 MHz. The Transmit Mixer is very similar to the

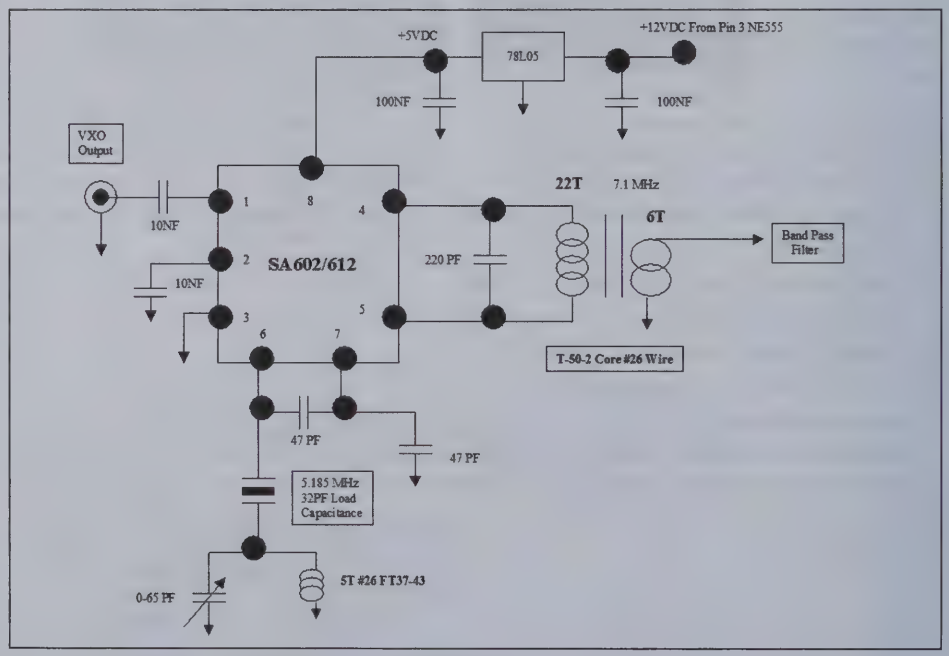


Figure 17—Transmitter mixer schematic.

Product Detector that was built for the receiver, so this should be familiar territory. It even takes its VXO input from the same point as the Product Detector, that is at the output of the VXO band pass filter. The 5.185 MHz crystal used in the Transmit Mixer is like the one used in the Product Detector. That is, it must be the type that needs a 32 pF load capacitance. A major difference between the two circuits is the way in which the output frequency is supplied to the following stage. For the product detector the output was taken from pin 4 of the SA602/612 and is known as a single ended output. In the case of our transmit mixer, a balanced output is taken across pins 4 & 5 which effectively leaves only the additive and subtractive mixer components. Because the stage has a tuned circuit output (the T-50-2 iron powder core and 220 pF capacitor), only the subtractive difference of the VXO minus the 5.185 MHz LO signal survives. This will result in an output between 7.015 and 7.040 MHz. Pretty cool, huh? There is another subtle difference between the two circuits in that the Product Detector runs continuously while the Transmit Mixer is turned off when a transmission is finished. We will discuss how this happens when the subject of TR switching is taken up. So now that you understand what is going on, wire up the Transmit Mixer circuit and take the familiar ten minute break before proceeding.

Now, check your wiring for any shorts or wiring errors and let's begin testing. To test this stage, connect the VXO and temporarily supply 12 VDC to the 78L05. Get the handy RF Probe out and check Pin 6 of the SA601/612 to see if there is any presence of RF. If so, that means the 5.185 crystal oscillator is working. There may have to be some adjustment of the trimmer cap to insure the circuit is oscillating. Next place the probe at the secondary of the tuned network across pins 4 & 5 and see if any output exists there. Once you have completed these tests, you can power up the receiver and the signal should be heard. (Be careful as the signal may be loud.) Start with the volume control at a low level and increase it slowly until you hear the signal at a comfortable level.) Since the VXO is tuned to the same frequency no matter where you tune the VXO you will hear the output at any setting of the VXO. Now we need to adjust the trimmer so that your transmitted signal is on the right side of a distant receiver's BFO frequency and the note is comfortable for the listener. If the received signal is on the other side of the BFO, you may fall outside the receiving passband and not be heard. The best way to make this adjustment is to have your station transceiver transmit into a dummy load and then listen for your station transceiver with the project receiver. Position the project receiver VXO such that the station transceiver has a pleasing note in your headphones. Now add a small piece of wire to the output of the transmit mixer to act as an antenna and apply power to the transmit mixer. You should hear the mixer output in your station transceiver. If not, adjust the trimmer until the signal is heard and the note is pleasing. Once you have insured that both transceivers can hear each other and you like the note, then your adjustment is finished.

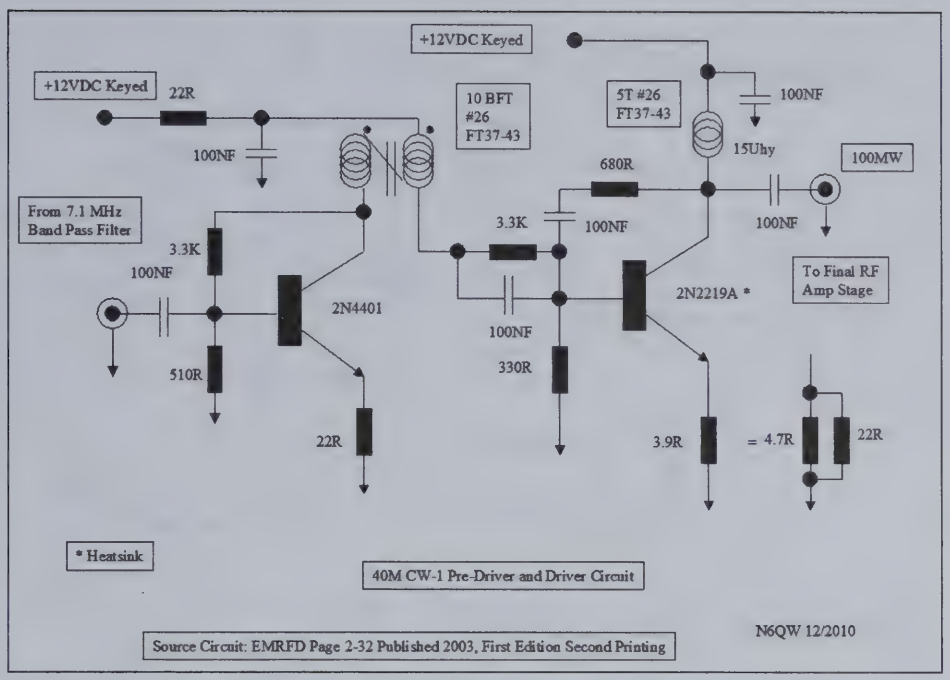


Figure 18—Pre-driver and driver schematic.

The next stage to be built is the 7.1 MHz Band Pass Filter and the circuit is shown in Figure 14 of Part 1. You should have no trouble with this stage as you have already built a very similar filter for your receiver. Once this stage is complete and you have taken your ten minute break, tack solder a 50-ohm resistor to ground across the secondary of the BPF. Power on the VXO (tuning it to around 7030 MHz) and the Transmit Mixer. Then, place the probe across the 50-ohm resistor and adjust the variable elements of the filter to produce the maximum signal at the output. This completes the alignment of this stage. If there is no output with any setting of the variable elements, check the obvious such as shorts and wiring errors.

Following the 7.1 MHz Band Pass Filter is the pre-driver and driver stage shown in Figure 18. With the exception of substituting a 2N4401 for the 2N3904 and a 2N2219A in lieu of the 2N3866, this is a direct lift from page 2.32 of EMRFD. So we know it works if it has been properly constructed and there are no bad parts. Construction is generally straightforward but there is one unusual item. Notice that the schematic in Figure 18 calls for a 3.9 ohm resistor to be attached to the 2N2219A emitter lead. This is not a common value, but is easily constructed by combining 4.7 ohm and 22 ohm resistors in parallel. You should also note that the 2N2219A requires a heat sink, which you can see in Figure 16. There are no adjustments to this stage; it either works or it doesn't. So, take your customary break and then check for poor solder joints and incorrect wiring.

This stage is tested like the others, by temporarily tack soldering a 50-ohm resistor to the output end of the 100 nF capacitor that is connected to the collector of the 2N2219A. Next, connect the VXO to the Transmit Mixer and provide power to the

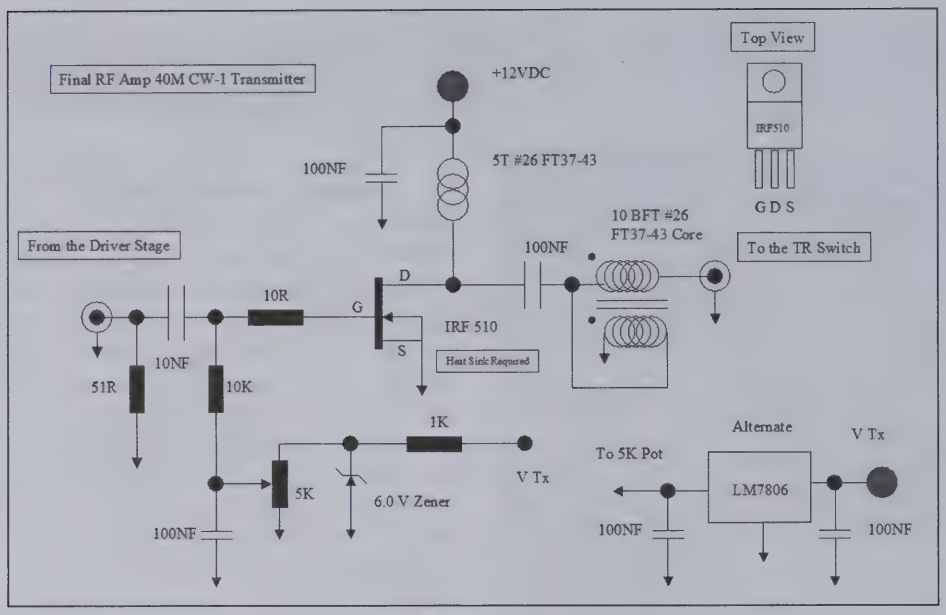


Figure 19—Final RF amplifier schematic.

SA602/612 78L05 voltage regulator. Listen for the signal in your receiver and check for an output at the secondary of the 7.1 MHz BPF.

Next, we need to power the pre-driver/driver stage in order to test it. Normally, that power would be supplied to the pre-driver/driver stage via a voltage that is only turned on during key-down periods. However for testing purposes and because we don't yet have a keyed voltage, we will just use a steady 12 V. source when necessary. In the final wiring, the +12 VDC to these two transistors will be provided from a keying transistor, which in this case is a TIP42 PNP power transistor. Thus, the mixer will be continuously running and it is the pre-driver/driver stage that is keyed. Because a steady 12 V. source creates a duty cycle higher than normal, it is a good idea to keep the power on periods as short as possible.

Just temporarily, touch the power lead for this stage to +12VDC. This is just to make sure nothing gets smoked. Assuming it passes the smoke test, next connect the two transistors to +12 VDC and measure the output across the 50-ohm resistor using the RF Probe. At this point the output should be in excess of 100 milliwatts. The RF probe should be measuring significantly more voltage than appeared at the input to these two stages and a 1/4-watt resistor should just feel a little warm. Now go back and peak the Band Pass Network and tune for maximum signal. (Again, don't keep this stage on for extended periods. If necessary, give the stage a short period to cool down before powering it up again.) This wiring of this stage is now complete. Actually, if one were to connect the low pass filter and a keyed voltage (both to be built later) this would be a transmitter that could be placed on the air.

As the last stage in the transmitter chain, we will build the final amplifier shown in Figure 19. This stage is also a lift from *EMRFD*, specifically Figure 2.98, and is also well proven. It uses the IRF510, a very cost-effective device costing less than $1 from sources such as Mouser, Digi-key and Jameco. Replacements can even be purchased at your local Radio Shack, costing nearly $2 but still meeting our criteria. During construction, you should note two things. First, the IRF510 has a device dissipation of 20 watts and a heat sink is mandatory. That device gets more than warm! When purchasing the TO-220 style heatsinks, find the largest size available and with the thickest material. Second, there are a couple of ways to provide the bias for the IRF510. The original *EMRFD* article used a dropping resistor and a Zener diode. The alternative is to use a small 6-volt regulator IC. There is little performance difference between the two sources, although I tend to avoid zeners in favor of the regulator. But in this case, I did use a zener.

You might also want to notice that the IRF510 is NOT keyed like the pre-driver and driver but is turned on by changing the bias voltage on this device, with the source of that bias being the voltage supplied and "timed" by the NE555 TR Switch. The IRF510 is connected to +12 VDC at all times, but without the bias voltage supplied by the TR Switch the IRF510 remains cut off. There is nothing critical to the building of this stage other than to set the small bias trimpot to about mid-rotation before applying power for the first time. This is so that when you power it up for the first time you do not exceed the device limitations. I found that the bias pot settings will enable an output from 1 watt to nearly 10 watts. Mid-rotation sets the output to about 5 watts. The tendency will be to set the output to 10 watts—but that is probably not a really good idea and will shorten the life of the IRF510. Five watts is sufficient for communicating with this radio at distances of several thousands of miles.

After taking the customary break and before applying power, check for cold solder joints and wiring errors. It is critical that a load be connected to the output before applying power and keying the transmitter. So let's take a moment to talk about dummy loads, which are nothing more than a device to absorb the power level of the transmitter. It must be a purely resistive load and not reactive. The output load impedance is 50-ohms and merely taking a 10-watt wire wound 50-ohm resistor and using that for a dummy load IS NOT the right answer! The load must be resistive and here is where paralleling of resistors comes in handy. If you take the same value of resistor and parallel them, the resultant value is simply found by taking the resistor value and dividing that by the number paralleled and the wattage rating becomes the sum of the individual wattage ratings. Ten 100 ohm, 1 watt resistors placed in parallel result in a 10 ohm resistor with a 10 watt rating. So if one takes twenty 1000 ohm 1/2 watt resistors and parallels them a dummy load of 50-ohms at 10 watts is created. A clever way to hook up 20 resistors in parallel is to take two pieces of 2" x 2" single sided copper PCB board and layout a grid pattern of 20 holes on one board, spaced sufficiently so that two resistors can be placed side by side. Place the board with the grid pattern on top of the other and drill through the boards using a small sized PCB board drill.

Once done, simply use the copper boards as end plates and solder both sides. Connect a wire to each board comprising the dummy load and terminate the wires in a SO-239, RCA or BNC connector. Another option is to use two 2 x 3" pieces of the single sided copper vector board—here the holes are already drilled and it is just a solder job.

The test procedure follows what has been done previously. Before applying power, check to make sure the bias pot is set at mid-rotation. You will need to make some temporary leads for applying power to the entire transmit chain. Again, we will use a straight 12 V, but we will need to do some pre-wiring to allow quick application and removal of power. The power for the transmit mixer can be supplied continuously by connection to the receiver power source. The remaining stage, pre-driver/driver and final stage, should have temporary wires for supplying 12 V and those wires should be soldered together so that power only needs to be supplied at one spot. The input voltage for the bias network in the final should also be connected at this spot. Thus, power can be supplied quickly to the keyed stages and removed if something is getting too warm. Now connect the dummy load to the output of the IRF510 with some sort of temporary wiring. Get out the RF Probe and connect that to the dummy load as well. Remember the Bias pot at mid-rotation! Now you can touch test the connected temporary wires to see if the stage is outputting RF. If it passes this test then make some small incremental adjustments to the trim pot to see which direction increases or decreases the power. Watch the heatsink—it will be hot! If all is well, remove the temporary wiring and we will proceed to the TR Switch circuitry.

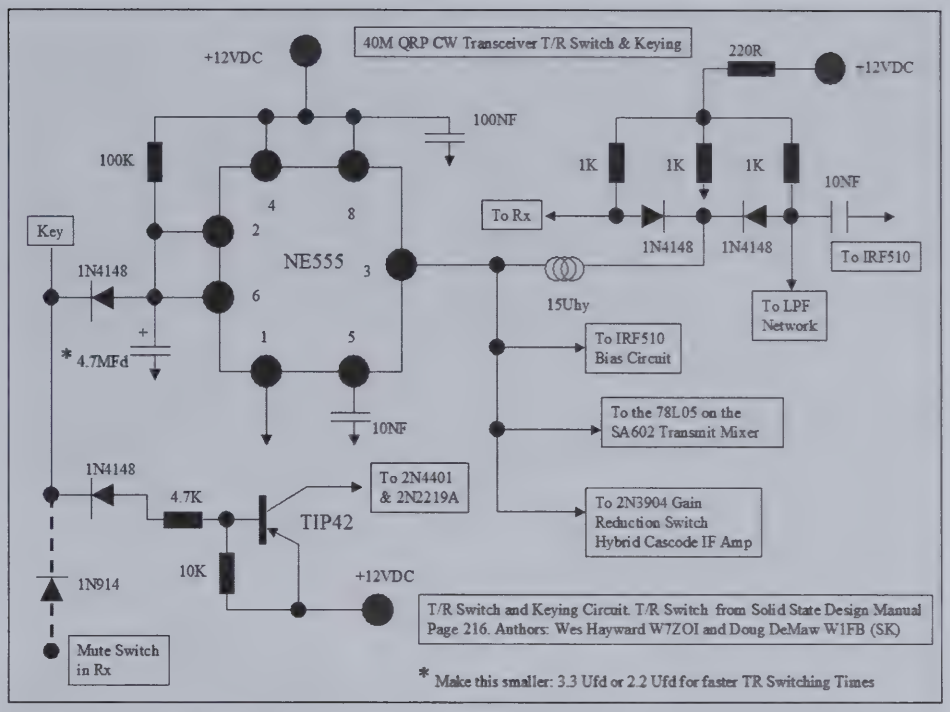


Figure 20—T/R switch and keying schematic.

TR switching is provided by the circuit of Figure 20, which was lifted directly from *Solid State Design for the Radio Amateur* by Wes Hayward and Doug DeMaw (SK). Switching starts when the key is closed, thus grounding the point marked "Key" in the figure and also the cathode of the 1N914 diode (shown with dotted line connections) attached to the base of the 2N3819 mute switch in the receiver. Grounding also causes the TIP42 to conduct providing voltage to the pre-driver/driver stage. Notice that all of these actions occur immediately when Key is grounded and stop each time the ground is lifted. The rest of the switching actions are controlled by the NE555 timer IC. The negative-going voltage transition caused by the key closing generates a timed +12 V pulse, which appears on pin 3 of the IC and supplies power to the final amplifier bias circuit, the transmit mixer and the gain reduction switch in the receiver IF amplifier stages. The pulse also reverse biases two diodes which removes the antenna from the receiver and switches it to the low pass filter at the output of the final amplifier and ultimately the antenna. Length of the pulse is set by the timing capacitor attached to pin 6 of the IC. The value chosen for the timing capacitor is such that power stays on the stages controlled by the pulse between dots and dashes, notably the transmit mixer. This prevents start-up effects in the mixer which can cause things like chirp on your signal. The value of 4.7 µF provides a pulse length appropriate to a fairly slow code speed. Speedier operators (not me) may want to decrease the timing period for faster break-in. A value of 3.3 µF might be a good place to start.

Now that you know what is going on, I suggest that you construct the switch but stop short of providing connections to the various transmitter and receiver stages not shown on the diagram. This will allow you to test the TR Switch independently without fear that might harm some other circuit if there is a mistake in your wiring.

After you finish constructing the stage, take the customary break and then check for shorts, bad solder joints and wiring errors. Now apply power and short the key to ground. Using an analog or digital voltmeter measure the voltage at Pin 3 on the NE555 and 12 VDC should appear at that in when the key is shorted to ground. When the key is opened the voltage remains on Pin 3 for a short period of time and then goes to zero. Short the key to ground again and observe that +12VDC appears at the collector of the TIP42. Remove the short and see that the voltage on the collector goes to zero.

If these two tests are passed then most of the final wiring to the transmitter and receiver boards can be completed. Take your time to insure that the 2N4401 and 2N2219A are connected to the Collector of the TIP42, that the Voltage Regulator for the SA602/612 is connected to Pin #3 on the NE555 and that the bias circuit for the IRF510 is also connected to Pin #3. One additional connection to Pin #3 goes the 2N3904 Gain Reduction switch on the Receiver Board. Finally, that there is a connection from the key jack to the mute switch on the 2N3819. Ordinary hookup wire is sufficient for these connections.

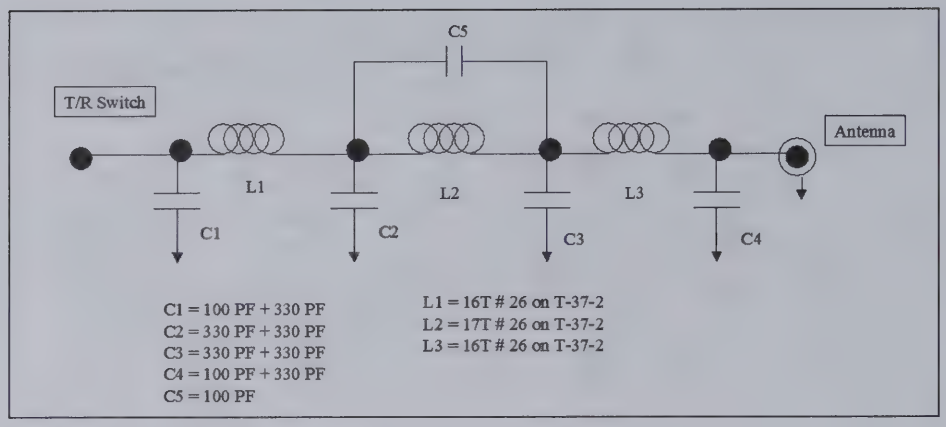


Figure 21—Low pass output filter.

The only remaining connection will be to the receiver RF input. If you are not building the optional RF amplifier in the receiver, then you can also connect the point in Figure 19 marked "To RX" directly to the RF Bandpass Filter in the receiver. I suggest that you use RG-174 small coaxial cable for this connection to avoid extraneous pickup of signals within the transmitter. If you are building the amplifier, then you will need to wait until the amplifier is completed before connecting to the receiver. Finally, you need to make internal connections between a single point where power enters the transceiver and all stages of the transceiver requiring power. I use a small terminal strip to distribute power to the VXO board, the receiver board and the transmitter board. There is no on/off switch in my version of the transceiver. Rather, I rely on the power supply on/off switch or simply physically disconnect the transceiver from its power source. Remember that you will need a power source supplying at least 11 V at all times in order to allow voltage regulators to work properly. Higher supply voltages will allow more transmit power. However, the use of supply voltages greater than about 15 V is discouraged as you might damage some components of your radio.

The transceiver is almost complete at this point. Remaining circuits are the low pass filter connected to the TR switch and the optional RF amplifier, should you decide to include this component.

The low pass filter is used to reduce the possibility of out of band operation or of having harmonic outputs on other bands in violation of FCC regulation. This Low Pass Filter has a cut-off frequency above the 40-meter band but way below any harmonically related bands. The filters are a direct lift from the work of Ed Whetherhold, W3NQN who documented his work on Page 44 of the February 1999, *QST*. It has superior second harmonic attenuation and is easily constructed using standard capacitors. This is shown in Figure 21.

The final optional component is the receiving RF Amplifier, which can be added to the transceiver at any time. The question of whether to include such an amplifier in a 40M transceiver is probably one of the most frequent discussions among homebrewers. The deciding factor is the external noise level, which generally decreases with frequency. As a rule of thumb, signals above say 20M most likely would benefit from a measure of RF amplification. At 40M, the desirability of such amplification is "iffy." If included, the amplifier may even reduce strong signal handling capability without adding weak signal sensitivity. For sure, there will be enough gain without the amplifier to provide a reasonable number of contacts. And if you find that the noise level increases in your receiver when you connect an external antenna, then you probably don't need the optional amplifier. The only other reason for adding the amplifier might be if you suffer from having some hearing loss. If this is the case, then strictly speaking you should add gain after the crystal filter. But, the optional RF amplifier may be an easier implementation. My hearing is not what it was back in 1950 when I would listen for the weak signals on my trusty crystal set. So, I found the amplifier to be a welcome addition. Figure 15 is the relevant schematic. I suggest that you build this stage on a small piece of PC board or vector board. My version, which used an MMIC in place of the 2N2219 shown in the schematic, is shown in Figure 16. Your version should be about the same size.

Once you have wired the RF Amplifier up and connected it to the TR Switch and the Receiver Bandpass Filter, your rig is now complete. However before you apply power to the transceiver, I need to give you a word of caution. You have not yet adjusted the TX gain reduction circuit in the receiver (see Figure 10 in Part 1). So, find the 1k ohm variable resistor shown in Figure 10 and adjust it using an ohmmeter so that there is no resistance shown between the potentiometer arm and the 1N4148 junction. This will shut of the receiver entirely when transmitting. Otherwise, a signal will appear on transmit that may be strong enough to harm your hearing.

Now, apply power to the transceiver and make sure it is receiving as you would expect. Connect a key to the transceiver and attach your dummy load to the transceiver output connector. Take off your earphones and transmit some dots while listening on your station transceiver. You should be able to hear output from your newly constructed transceiver and verify that it is working correctly. Place one earphone a short distance from your ear and verify that a sidetone is not being heard when transmitting. If all is well put the earphones back on and adjust the variable resistor in Figure 10 until the sidetone appears at a comfortable level.

Your transceiver is now ready for action. It's a good idea to leave this rig on the workbench for a while before attempting to package it up and declare it finished. Tune around and make a few QSOs first. Get some on the air reports on signal quality and learn how the rig operates.

Don't be surprised if you get hooked on using this little rig and be too busy operating to package it up for quite a while. There is nothing wrong with satisfying your curiosity about its performance. In my own case, I worked about 20 stations in just a few days of operating and the best DX has been a 2000-mile contact where I received a 579. Imagine my surprise several mornings ago when I was listening at the low end of 40M and from my QTH in Washington, near Seattle when I heard a 9M6 station (in Maylasia) calling CQ. He

was clipping along at about 35 WPM. I was tempted to answer him but that speed far exceeds my abilities as a CW operator. So, I just listened and caught a letter here and there. JA's are easy to spot and hear, as are many other DX stations. So the receiver satisfies the need to be sensitive, selective and above all have a good dynamic range. Signal reports regarding stability and purity of the output signal have been uniformly good. Subjectively I think it does a really good job for a homebrew transceiver. Mind you, all I did is hookup a bunch of well-proven circuits so one should expect that it will do a nice job!

When you do get around to packaging the rig, there are several possibilities. Figure 22 shows my version. In this particular project, I made the boards so that they could be stacked upon one another using one inch threaded aluminum pillars. This has the advantage of a smaller footprint but also means any time you want to make changes or troubleshoot a circuit some disassembly is required. Small looks nice; but it comes with a price. On the other hand, this type of packaging does allow you to make changes without being constrained by an expensive box. If you do decide to purchase a commercial enclosure, then a box with a 6" x 8" footprint at least three inches high would do the trick. But these are not cheap. Another option is to purchase PCB stock and fabricate your own enclosure. I have noted that on one of the auction sites a bundle of various PCB scrap pieces can typically be purchased rather inexpensively. Still another option is to purchase a hand brake from suppliers such as Harbor Freight. I bought an 18" unit for around $28 and have made many boxes and parts on that unit.

Finally, I would note that there are lots of changes and enhancements you can add to this transceiver. Since you built it yourself, it should be relatively easy to alter it as you desire. Some ideas for enhancements include:

- Adding RIT circuitry to the VXO
- A manual IF gain control or AGC circuit
- Replacing the VXO with something like the Si570-based synthesizer kit designed by K5BCQ for increased frequency range. (You might even decide to use this synthesizer to turn the transceiver into a multiband rig.)
- And, adding an active audio filter for greater selectivity or notching QRM.

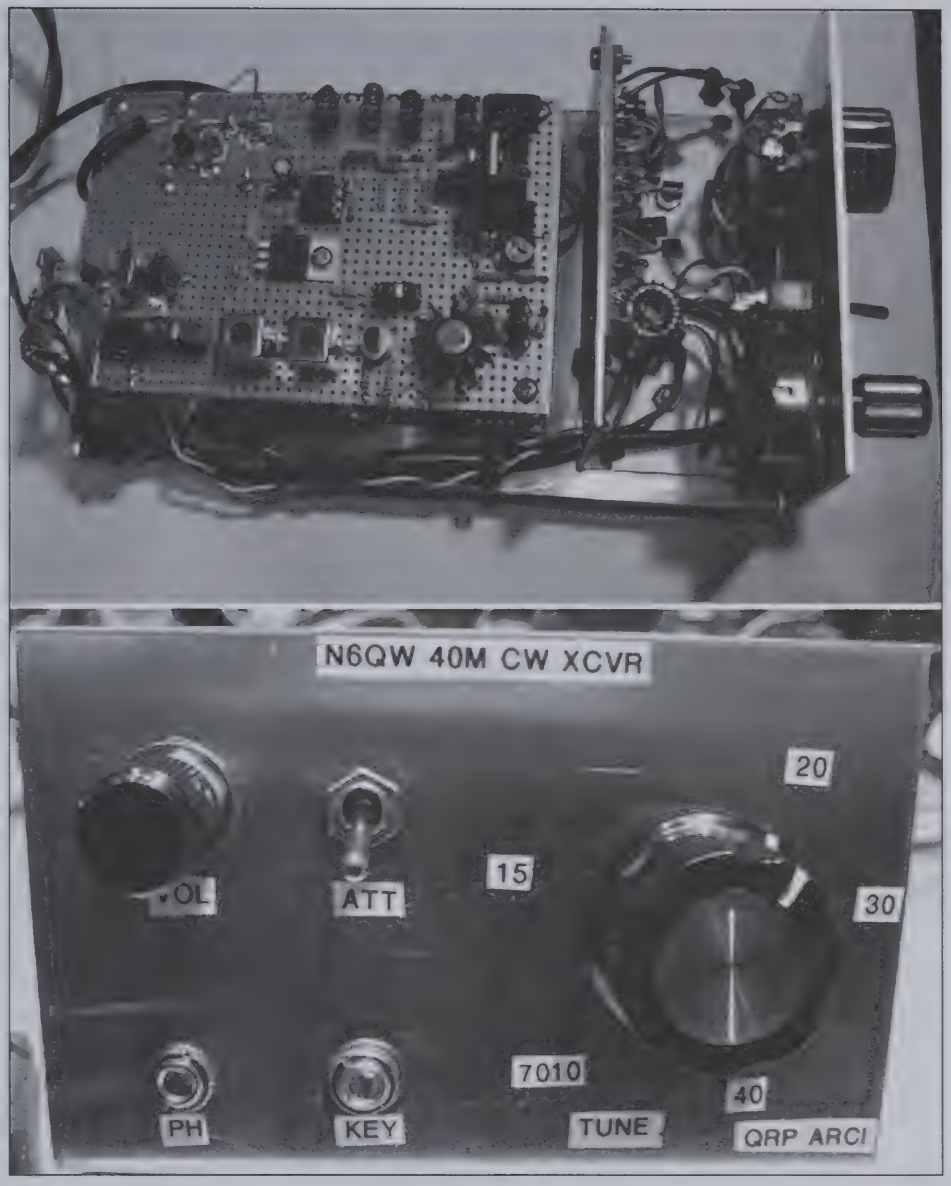


Figure 22—The completed transceiver.

None of these ideas were included here because this was after all a beginning project for new builders. But now that you have caught the building bug, you can experiment to your heart's content. If your idea doesn't work quite the way you expected, no harm done except for the smoking of a few inexpensive parts. And, look at how much you will have learned regardless of the outcome!

I hope that those of you who construct this project have as much fun as I did in coming up with the final result. I welcome hearing from those who have built the radio and any feedback about your experiences, both positive and negative. I have been totally surprised by the number of comments that Part 1 has generated. The only way I can improve my articles is to have your feedback. Keep those soldering irons hot and always be on the lookout for new improvements to your radio.

—73s de N6QW

P.S.—Earlier in this article, I promised to write about the design of our transceiver project but deferred that discussion in order to let you start building. I have placed that discussion on my web page, along with the expanded schematics and parts lists, in order to keep the size of this article manageable.

●●

Antennas 101: The Enlongated Loop

Gary Breed—K9AY k9ay@k9ay.com

Full-wave loops are popular ham antennas, usually in a quad loop (square or diamond) or triangle (delta loop) configuration. These loop antennas typically provide roughly 1 dB gain over a dipole in their favored directions, but they usually have a feedpoint impedance higher than 50 ohms, resulting in a 1.5:1 to 2:1 VSWR when fed directly with 50-ohm coax. This article describes a variation on the shape of a loop that provides a better 50-ohm match, with the bonus of some extra gain.

Playing With the Shape of a Loop

Figure 1 shows several different loop shapes, along with their respective feedpoint impedances. The EZNEC models I used to compare them had the antenna at a height of 1/2 wavelength at the center of the loop. The top four shapes include the common square, diamond and delta loops, along with a hexagonal loop intended to approximate a circular loop, which has the largest enclosed area for a particular wire length. Notice that all four have a high feedpoint impedance, between 121-131 ohms. Of course, this range of impedances range can be transformed to near 50 ohms using a 1/4-wave section of 75 ohm coax, but that is extra work, with another connection that may be hanging in the air.

The bottom two shapes are the horizontal and vertical arrangements of a rectangle with a height/width ratio of 2:1. The horizontal version has a higher impedance than the more symmetrical shapes, which provides no advantage. But the vertical configuration has a feedpoint impedance almost exactly 50 ohms. (Note that there is nothing magical about the simple 2:1 *h/w* ratio—it's just a coincidence.)

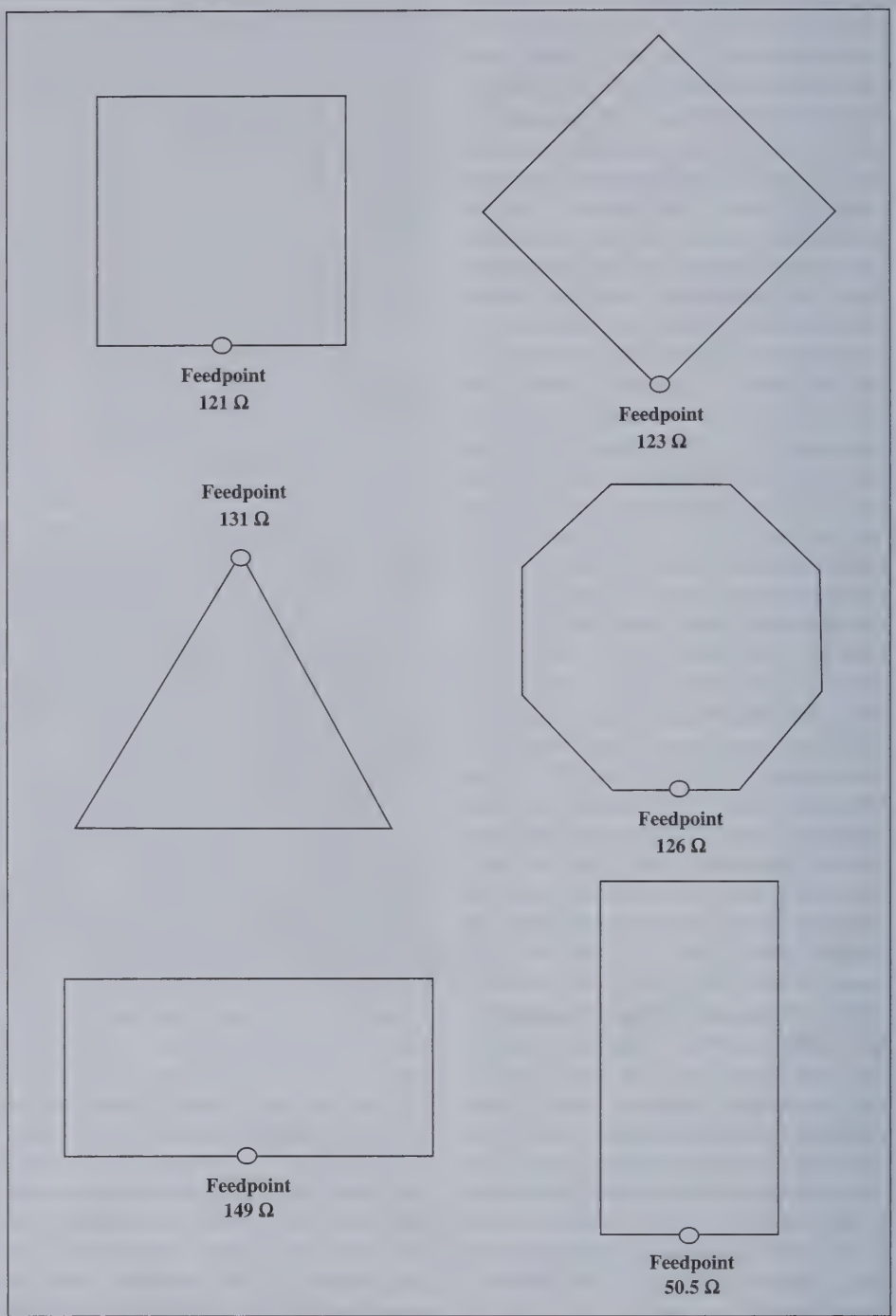


Figure 1—Feedpoint impedance (at resonance) for several different shapes of full-wave loop antennas, with centers at 1/2 wavelength above ground.

Enlongated Loop Radiation Pattern

OK, now that we have a loop with a near-perfect 50-ohm match, does it radiate like the other full-wave loops? Actually, it's better!

Take a look at the EZNEC pattern plots of Figures 2 and 3. The enlongated loop is compared to a typical delta loop at the same height, which in this case is about 1/2 wavelength. It is quite clear that the enlongated loop has more gain than the delta loop. The difference is just about 2 dB, which is a lot—like going from 5 watts to 8 watts. When the comparison is made to a square or diamond shaped loop, the added gain is a couple tenths of a dB less. The delta loop's acute angles reduce its efficiency slightly, compared to the square corners of the other equal-sided loops.

Where does this gain come from? It comes from the wider spacing between the points of maximum current—the bottom feedpoint and the point 1/2-wave around the perimeter, which is at the top. You can

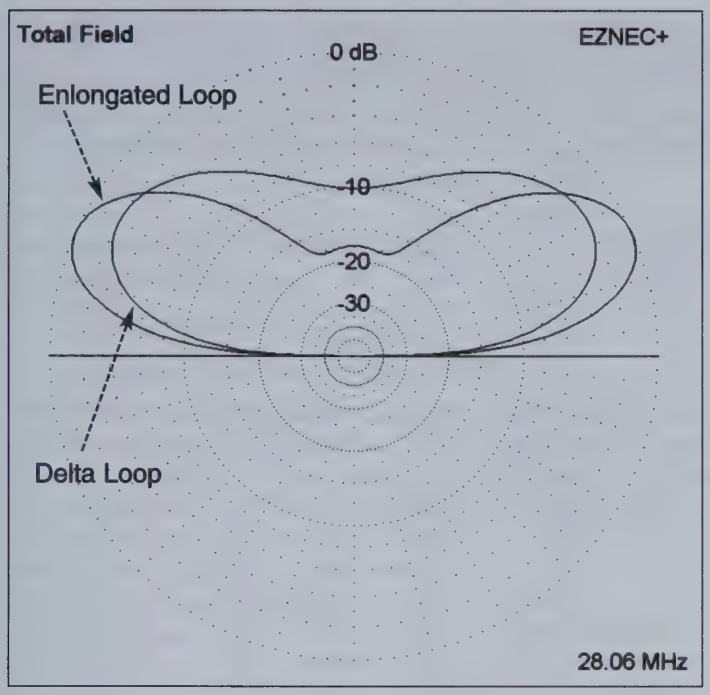


Figure 2—Vertical pattern plots; delta loop and enlongated loop at the same height (approx. λ/2).

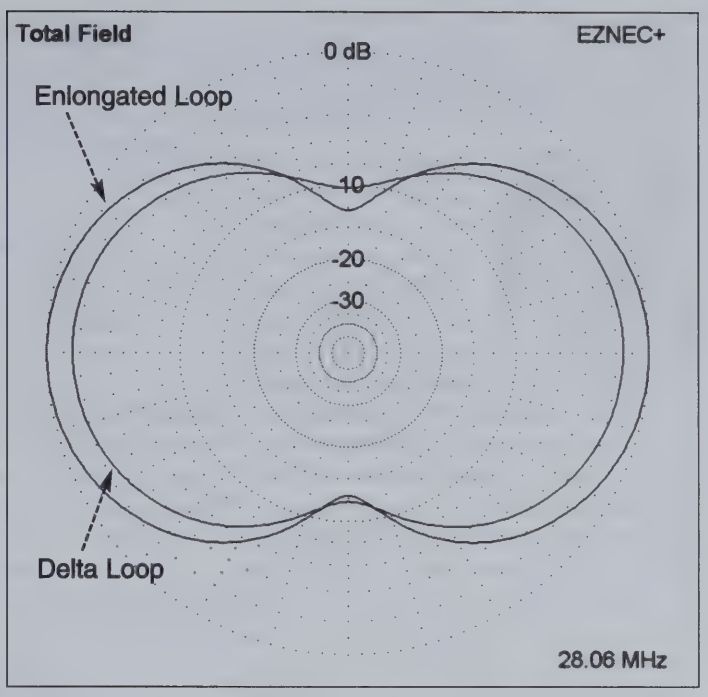


Figure 3—Horizontal pattern plots (30° elevation); delta loop and enlongated loop at the same height (approx. λ/2).

think of it as being similar to two stacked dipoles. The current maxima "elements" are not really dipoles, but the idea is the same.

The main advantage of this loop configuration is that you get the extra gain for free! There is no more wire than other loops, and construction isn't any more complicated than a square or diamond shaped loop. And the perfect match to 50 ohm coax is a bonus.

VSWR Bandwidth

The enlongated loop has a bandwidth pretty much the same as any other loop. The three VSWR plots of Figure 4 tell the story. When cut for the 10M QRP CW calling frequency (28.060 MHz), the SSB frequency (28.385 MHz) will have a VSWR around 1.8:1. When the loop is cut for phone, the CW frequency is about the same. A compromise adjustment midway between those frequencies allows coverage from the bottom of the band to around 28.4 MHz with VSWR less than 1.5, with a 2:1 VSWR point well above 28.5 MHz. Other bands will behave similarly, of course.

The dimensions for the three tunings are shown in the inset at the top of Fig. 4. These measurements will vary somewhat with height above ground, nearby metallic objects and wire size, but they are good starting points. A little pruning will put the VSWR "sweet spot" right where you want it.

Operating Experiences

I'd been wanting to try this antenna for a while when I first built it to use in the 1997 ARRL 10M Contest. I would be working at an investment property we were remodeling, and wanted to be able to operate during work breaks. My rig was a converted SSB CB radio, and I made more than 100 QSOs all over the US, and with DX all over, including Europe, South America, VK and ZL. This was near the maximum of the last sunspot cycle, so conditions were excellent—but that didn't diminish the fun of reaching halfway around the world on SSB with QRP power! ●●

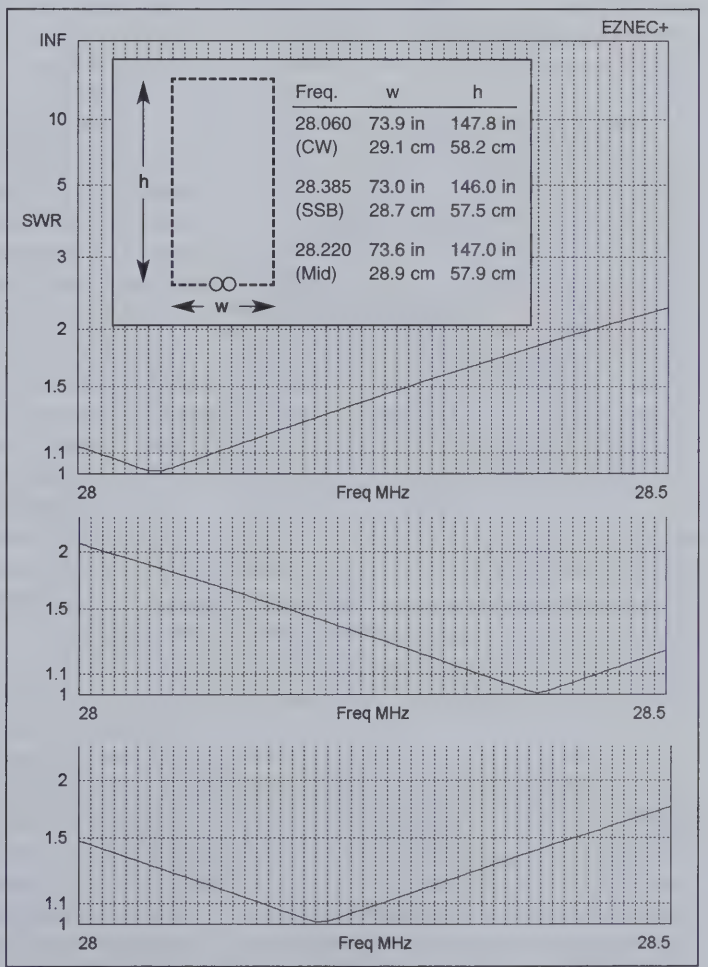
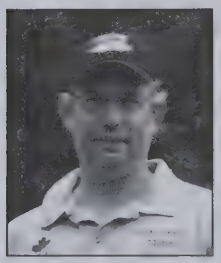


Figure 4—Comparison of VSWR plots for enlongated loops cut for 28.060 MHz (top), 28.385 MHz (center), and midway between those frequencies (bottom).

QRP Contests

Jeff Hetherington—VA3JFF

contest@qrparci.org



Summer is now upon us, and many of us are participating in a variety of exciting outdoor activities. For some of us, this means that radio is put aside, and for others, it is brought to the forefront as we take our radios out to the field for some good clean fun. The 50th Anniversary of QRP-ARCI continues throughout the summer, and K6JSS will be on the air during most QRP-ARCI Contest events. Furthermore, October is world-wide QRP Month to celebrate the 50th Anniversary of the club, and special event stations are planned from several countries around the world. At the time of printing, VC3ARCI from Ontario, Canada has been authorized for use during the month of October and will be active during the Fall QSO Party as well as at other times in the month. We are optimistic that other DX entities will grant the authority for special event stations to help the club celebrate it's international roots. Watch the various email lists and the http://www.qrpspots.com for more information as it is finalized and the stations begin to appear on the air.

It was good to see so many of you at FDIM and the Dayton Hamvention this year, and it was nice to hear suggestions on how to make our contests better. The full 2012 QRP-ARCI Contest Calendar will be published in the next issue of *QRP Quarterly* and it will feature some changes that have come about as a result of the suggestions that I have received in person and by email. If you have any ideas, please submit them to the email address at the top of this page so that they may be considered before the finalization of next year's Contest Calendar.

For regular readers of this column, you may be looking for the results from this spring's running of the Hootowl Sprint. Due to the rotating strikes and lockouts affecting Canada Post mail service, the deadline has been extended for paper entries to ensure that all entries currently delayed because of the labour disruption will have an opportunity to make the final results. Also, please note that starting in January of 2011, the deadline for contest submissions was shortened to 14 days after the end of the contest. Please be prompt in submitting your logs.

Mark ur Calendars

10-12 September 2011	**End of Summer VHF Contest**
15-16 October 2011	**Fall QSO Party**
1 December 2011	**Top Band Sprint**
18 December 2011	**Holiday Spirits Homebrew Sprint**

The annual running of the Grid Square sprint is always fun for many operators as it allows us to deviate from our standard exchanges and makes sure that the operators pay attention and don't fall into the trance of 599-state type exchange. Furthermore, distance of the QSO is easy to calculate since you can use utilities such as the one located at http://www.chris.org/cgi-bin/finddis. If you are chasing the QRP-ARCI 1000 mi/watt award, this is a great contest and way to track that down. This year the top spot was once again claimed by Bob Patten, N4BP with a total of 97,104 points. This total easily outdistanced a tough battle between second and third place. Joe Vrabel, KD2JC stayed ahead of Tim Colbert, K3HX by only 301 points, taking second place with 16,240 points as compared to third place 15,939 points. New member Eric Manning, VA7DZ finished fourth with 13,300 points and rounding out the top five was Will Bowser, K9FO with 12,502 points.

The Spring QSO Party always brings out plenty of participants, this year 82 entries were received and there were many more calls seen in the logs that did not submit their logs. Furthermore, entries were received from Canada, England, Spain, Canary Islands and most of the individual states in the United States. This is the contest that gives participants the chance to finish off their WAS award as issued by either ARRL or QRP-ARCI. The Multi-Op category was won by the group of KK6MC, AA5B, WD9FJL, KE5AKL operating under the callsing KK6MC. They made a total of 317 QSOs for a grand total of 864,367 points and found their way into many of the logs that were received. In the single operator category, the top score went to John Thompson, K3MD whose total of 427,518 points edged out Arnold Olean, KØZK and his total of 413,910 points in one of the closest battles for the championship in many years. Nick Thoma, NT1A and Dana A. "Mike" Michael, W3TS were in an equally close battle for third and fourth place, with NT1A slipping by with 298,368 points to the 297,860 point total of W3TS. Tim Colbert, K3HX totaled 262,941 points for fifth place, Bob Patten, N4BP used 20m only for 228,900 points and sixth place overall, while John T. Laney III, K4BAI took seventh spot with 224,028 points. The top ten were rounded out by Ken Newman, N2CQ with 217,140 points, Dennis Cobb, WA8ZBT with 214,900 points and Jim Fitton, W1FMR with 196,245 points.

Until next time, keep your power down and your QSO rates up.

—73/72, Jeff, VA3JFF

Top 5 Grid Square Sprint

Bob Patten, N4BP	97,104 pts
Joe Vrabel, KD2JC	16,240 pts
Tim Colbert, K3HX	15,939 pts
Eric Manning, VA7DZ	13,300 pts
Will Bowser, K9FO	12,502 pts

Grid Square Sprint Soapbox:

Seemed like pretty good participation and decent opening on 15m. Fun Sprint. —**N4BP**

Nice Sprint. Propagation getting better, 15m is opening more frequently. — **KD2JC**

40m noisy, QRN. 20M very active. Always great fun! —**K3HX**

Conditions pretty good on 20m & 15m, nothing on 10m. —**K9FO**

Nice to see 15m open during this contest. —**AI2T**

2011 Grid Square Sprint Results

NAME	Call	STATE	BANDS	POWER	QSOs	PTS	GRID	MULT	SCORE	RIG & ANTENNA
Bob Patten	N4BP	FL	15/20	< 5W	58	272	51	7	97104	K3, Cushcraft A4S
Joe Vrabel	KD2JC	NJ	ALL	< 5W	25	116	20	7	16240	K2, 40m loop, triband yagi
Tim Colbert	K3HX	PA	ALL	< 5W	24	99	23	7	15939	Orion I
Eric Manning	VA7DZ	BC	15/20	< 5W	20	100	19	7	13300	
Will Bowser	K9FO	IL	15/20	< 5W		94	19	7	12502	Ten Tec Orion, Tri-band rotatable dipole
Peter Potts	W1PNS	MA	ALL	< 5W	22	79	19	7	10507	
Fred Muehlen	N5WLA	TX	15/20	< 5W	18	75	18	7	9450	K3, Mosley classic 33
Ken Newman	N2CQ	NJ	ALL	< 5W	16	65	16	7	7280	IC706MKIIG, Force 12 C3SS and doublet
Barry Ives	AI2T	NY	ALL	< 5W	16	65	15	7	6825	K1, 3 el triband yagi, CF Zepp
Scott McMullen	W5ESE	TX	ALL	< 5W	15	69	14	7	6762	Argonaut 509, 100m HOHPL, 15m vert. dipole
Dave Mueller	AA3EE/3	PA	20	< 5W	4	20	4	7	5560	K2, DK9SQ Vertical Loop
Jim Wilson	VE3MO	ON	15/20	< 500mW	2	10	2	15	5300	Wilderness Sierra, Temporary Inv L
Michel Boissonnault	VE2TH	QC	20/40	< 5W	13	56	13	7	5096	FT817ND, Inv Vee
Barry Strickland	AB4QL	AL	High	< 5W	10	50	10	7	3500	K1, Trap Vertical
Jim Anderson	NV9X		ALL	< 5W	11	49	8	7	2744	FT857D, 3 el yagi, dipole
Anton Vermaak	N9WAY	WI	20	< 5W	8	40	8	7	2240	TS120V, 40m OCF dipole
Harold Slack	VE3BCS	SK	ALL	< 5W	8	34	8	7	1904	
Frank Van Cleve	KB3AAG	PA	20	< 5W	7	35	7	7	1715	
Edwin "Ted" Albert	AB8FJ	OH	15/20	< 5W	7	32	7	7	1568	
Mike Blama	WA8SAN	OH	20/40	< 5W	6	30	6	7	1260	
Rene Correa	K5JX	TX	15/20	< 5W	5	18	5	7	630	
Robert MacKenzie	VA3RKM	ON	10/15	< 5W	3	15	3	7	315	
Mike Tate	VA6FUN	AB	15	< 5W	3	12	3	7	252	HW9, Spiderbeam
QRP Mosquitos	W5MSQ	TX	ALL	< 5W		109	23	7	22549	FT817s, Vertical, EFHW
Jean Charron	VE2JCW	QC	ALL	< 5W	14					Checklog

Good conditions on 15m, and an encouraging level of activity. Tried 10m with no takers. —**W5ESE**

It started out as a beautiful morning, warming quickly under blue skies. I was about 30 minutes late leaving the house, so I didn't get started raising the antenna until about 10AM. It took longer than I thought, I didn't raise the support mast as high as usual so all the guys were too long. I was able to work in the light coating of snow with just a sweatshirt and gloves. After the antenna was up, I put the K2 on the picnic table, connected the battery and antenna. As soon as I turned it on, the wind started. Then the clouds moved in. The DK9SQ loop wasn't guyed, so it windmilled half the time and spent the other half of the time bent over at a 45 degree angle in the wind. I spent about an hour just tuning around the bands listening. My first QSO was K6JSS/7, which made it all worth it since I need Idaho for my WAS. This was my first real QRP contest, it was strange not to hear 100 stations at S9+20. It was also the maiden portable run for my K2 and the DK9SQ antenna system. Lots of fun, I look forward to doing it again. —**AA3EE/3**

Well solar conditions can best be described in 3 words: "THE WORST EVER" but, looking at it optimistically, it makes it easy to send in a log. I operated a Wilderness Radio Sierra at 200 mW to a temporary Inverted L antenna thrown up into my maple tree in the back yard. Over the 2.5 hours that I participated I tried 80 thru 10 meters and only managed to contact Bob (N4BP) in Florida—twice on 2 bands. I had a couple of other "hits" but they faded away as fast as they came. Well, that's about it. Ironic isn't it—We wait for the sunspots to start up in the hopes of good propagation, but along with them come the flares which wipe everything out. —**VE3MO**

A "FUN" time for me. —**VA6FUN**

Multi Op: W5ACM, WA5BUC, N5EM, portable at Ray Miller Park, Houston, Texas. —**W5MSQ**

Spring QSO Party Soapbox:

Multi Op Station with Ops: KK6MC, AA5B, WD9FJL, KE5AKL —**KK6MC**

EA2LU had an amazing presence on 15 and 20m: What antenna, Jorge? — **KØZK**

Had a lot of fun in my 2nd Spring QSO party. Some old faces and many new faces seen. Condx seemed pretty good to me. I wished that more people would have tried 15m and 10m. Casual effort with lots of breaks for family time in between. — **NT1A**

Good to again meet old friends. — **K3HX**

Spent Saturday in the SOC K8DD Memorial CW Bash. Condx seemed much better on Sunday for the ARCI Party. — **N4BP**

Very good conditions on the late night hours, this year little bit more activity from European stations. Still not QSO on 10m, but I can work west coast and surprisingly VK4TJ called me from the back of my antenna, also first time I broken the 100 Qs barrier, as always an entertaining and fun contest. Thanks to all that called me and sorry those I couldn't heard, see you next

Top 10 Spring QSO Party

John Thompson, K3MD	427,518 pts
Arnold Olean, KØZK	413,910 pts
Nick Thomas, NT1A	298,368 pts
"Mike" Michael, W3TS	297,860 pts
Tim Colbert, K3HX	262,941 pts
Bob Patten, N4BP	228,900 pts
John T. Laney III, K4BAI	224,028 pts
Ken Newman, N2CQ	217,140 pts
Dennis Cobb, WA8ZBT	214,900 pts
Jim Fitton, W1FMR	196,245 pts

2011 QRP ARCI Spring QSO Party Results

NAME	Call	STATE	BANDS	POWER	QSOs	PTS	SPC	MULT	SCORE	RIG & ANTENNA
Multi Op	KK6MC	NM	ALL	< 5W	317	1273	97	7	864367	
John Thompson	K3MD	PA		< 5W	195	783	78	7	427518	
Arnold Olean	KØZK	ME	ALL	< 5W	158	657	90	7	413910	K3, 30ft ground plane on roof of 2 story metal building
Nick Thomas	NT1A	NH	ALL	< 5W		592	72	7	298368	K3, C3 Yagi, 40m vertical, 80m dipole
"Mike" Michael	W3TS	PA	ALL	< 1W		562	53	10	297860	Orion, 160M 1/8 wave tee, 80/40M Dipole, 2el 20M yagi
Tim Colbert	K3HX	PA	ALL	< 5W	145	659	57	7	262941	Orion I, 40-20 Dipoles, 80m vertical
Bob Patten	N4BP	FL	20	< 5W	150	654	50	7	228900	K3, Cushcraft A4S
John T. Laney III	K4BAI	GA	ALL	< 5W	111	508	63	7	224028	FT1000MP, TH6DXX, zepp, dipole, inv-V
Ken Newman	N2CQ	NJ	ALL	< 5W	120	517	60	7	217140	IC706MKIIG, Force 12C-3SS, Doublet
Dennis Cobb	WA8ZBT	TX	ALL	< 5W	144	614	50	7	214900	
Jim Fitton	W1FMR	NH	ALL	< 5W		445	63	7	196245	FT817, End Fed Wire
Jorge R. Daglio Accunzi	EA2LU		15/20	< 5W	109	482	57	7	192318	IC7800, Cushcraft 3el X7
Paul Kirley	W8TM	OH	ALL	< 5W	111	486	50	7	170100	K3, 40m inv vee
Hank Greeb	N8XX	MI	ALL	< 5W		421	53	7	156191	Drake TR-5, dipole
Jim Lageson	NØUR	MN	ALL	< 5W	91	418	52	7	152152	
Charles Fulp	K3WW	PA	ALL	< 5W	88	390	52	7	141960	
Robert MacKenzie	VA3RKM	ON	ALL	< 5W		397	50	7	138950	K2, Verticals, Wires
Will Bowser	K9FO	IL	ALL	< 5W	86	393	49	7	134799	Flex1500, 20m & 40m dipoles, 80m LW
Frank Van Cleve	KB3AAG	PA	ALL	< 5W	89	382	46	7	123004	
Joseph G. Gay	W4RYW	AL	ALL	< 1W	66	300	39	10	117000	K3
Thomas Valenti	K3AJ	MD	ALL	< 5W		317	46	7	102074	Ten Tec Eagle, 80/40 Inv V, 3 ele yagi
Wes Baden	K6EIL	UT	20	< 5W	108	456	30	7	95760	Ten Tec R4020, 3 el yagi
Paul Beringer	NG7Z	WA	ALL	< 5W	76	335	40	7	93800	IC756 x2, Yagi and wire
Randy Drake	KB4QQJ	NC	ALL	< 5W		294	45	7	92610	FT817, Doublet, PAR EndFedz
John McBee	KM5PS	AR	ALL	< 5W		301	42	7	88494	K3, Tribander, dipoles
Dick Bentley	K2UFT	GA	ALL	< 5W	57	261	38	7	69426	
William Schmidt	WV1N	CT	ALL	< 5W	55	254	39	7	69342	ATS4, 135ft CFZ
Barry Ives	AI2T	NY	ALL	< 5W	58	267	34	7	63546	K1, CF Zepp, 3 ele yagi
Pat Byers	VE3EUR	ON	ALL	< 5W		229	39	7	62517	IC703, Drake TR5, NC2030, Cushcraft R4, 40m vertical
Scott McMullen	W5ESE	TX	ALL	< 5W	52	233	36	7	58716	Argonaut V, 10m HOHPL
Robert Nash	VE3KZ	ON	ALL	< 5W	52	232	35	7	56840	IC706MKIIG, 40m sloping dipole, 20m 3 ele yagi, 15m 5 ele yagi
Mark Katchel	NØOKS	WI	ALL	< 5W	57	201	35	7	49245	K3, Hustler 5-BTV
Ed Dybowski	WD7Y	NV	ALL	< 5W	53	158	43	7	47558	Ten Tec Orion 2, 102ft doublet
Chuck Sullivan	WA1IIE	ME	ALL	< 1W	39	174	25	10	43500	
Bruce Plantz	K9OZ	IL	ALL	< 5W	47	211	28	7	41356	K3, SteppIR Vertical, 80m dipole
Roger Monroe	K7NTW	WA	20	< 5W	49	224	26	7	40768	Omni 6+, 2 el quad
Joe White	WA4GIR	NC	ALL	< 5W		201	27	7	37989	K1, Sierra, Dipole, Vertical
Newton White	KØNWT	GA	ALL	< 5W		178	29	7	36134	FT450, G5RV, Inv L
Ray Cornelison	KJ4AOM	KY	40	< 5W		228	20	7	31920	K3, OCF Dipole
Alan Shafer	AC8AP	OH	20/40	< 250mW	25	112	19	15	31920	IC703+, G5RV
Jim Cluett	W1PID	NH	ALL	< 5W		172	26	7	31304	OCF Dipole

(continued on next page)

Fall QSO Party —**EA2LU**

Lousey propagation on 20 discouraged many folks. Did manage to work two Europeans on 20 metres. This was a good test of my "new" ATU and computer to rig interface. Congrats on running a nice party! —**N8XX**

Terribly noisy bands at times. But fun as usual. —**VA3RKM**

No 10M or 15M here and 20M was up and down. 40M and 80M pretty noisy but fought on anyway My first "big" contest with the Flex 1500. RX is great. CW TX much better with latest software. —**K9FO**

This is my first try at a national contest! Thanks to all that put up with my requests for repeats. And after all that to discover I was only a two point contact! —**KB3AAG**

Lots of fun—tried 15M but no luck. Was dead here. —**W4RYW**

Only had 6 hours to work the contest this year. 15M was a bust, kept the 2nd radio there to listen, but never heard anyone. I CQ'd many times on 15m but no answers. Not much chance to use 40m or 80m due to other duties at home. —**NG7Z**

2011 QRP ARCI Spring QSO Party Results (continued)

NAME	Call	STATE	BANDS	POWER	QSOs	PTS	SPC	MULT	SCORE	RIG & ANTENNA
Andrew Measday	WA5RML	TX	20/40	< 5W	42	186	24	7	31248	FT817ND, 40m dipole, 20m vertical
David Reid	VE6BIR/7	BC	ALL	< 5W	50	232	19	7	30856	FT817, TH3, dipole
Joe Vrabel	KD2JC	NJ	ALL	< 5W		162	25	7	28350	K2, 40m loop, triband yagi
John T. Collins	KN1H	NH	ALL	< 5W	31	146	25	7	25550	IC718.
George Tibbett	KF4UCC	VA	20/40	< 5W	30	135	23	7	21735	
Merton Nellis	WØUFO	MN	ALL	< 5W	31	140	21	7	20580	K3.
Kevin Clemetns	VE3RCN	ON	ALL	< 5W		124	21	7	18228	TS2000
John Harper	AE5X	TX	20/40	< 5W	25	122	21	7	17934	
Rollin F. Pettingill	N7RN	AZ	ALL	< 5W		125	20	7	17500	IC756PROIII 3 el yagi
Mike Baker	K7DD	AZ	20/40	< 5W		136	18	7	17136	
Jim Polewczak	KG2H	NY	ALL	< 5W		127	19	7	16891	K2 Dipole
Don Minkoff	NK6A	CA	ALL	< 5W	27	126	19	7	16758	K3 Force 12C4, 88ft dipole
Paul M. O'Brien	K1CM	MA	20/40	< 5W	24	110	19	7	14630	K2 Wire Loops Indoor
Pete Quinn	N1PQ	MA	ALL	< 5W	23	107	18	7	13482	IC703+ EFHW
Thomas L. Collinvitti	WB8EJN	MO	20	< 5W	23	115	16	7	12880	IC706MKIIG Butternut Vertical
Steve Yates	AA5TB	TX	ALL	< 5W		98	16	7	10976	FT897D Inv L
John Paul Keon	AB4PP	NC	ALL	< 5W	19	91	17	7	10829	
Raymond Albers	K2HYD	NC	40	< 5W		104	14	7	10192	KX1 Non-Resonant Doublet
Jim Stafford	W4QO	GA	20/40	< 5W		79	15	7	8295	K3 HZ Loop
Dick McClain	N9XO	IN	ALL	< 5W	16	77	14	7	7546	IC706MKIIG SteppIR Vertical
Brock Thomsen	W6GMT	MN	40	< 5W	14	70	10	7	4900	
Alan Pampling	G3RSP		20	< 5W	13	65	10	7	4550	SW20+ 3 ele yagi
Derek Brown	WF4I	NC	ALL	< 5W		53	11	7	4081	K2 Doublet
Philip Gratcier	W3HZZ	GA	20	< 5W	12	57	10	7	3990	KX1 84ft W3EDP
Ken Norman	VE7KBN	BC	20	< 5W	11	55	10	7	3850	IC7000 Cushcraft Vertical
Fred Lesnick	VE3FAL	ON	20/40	< 5W	10	47	9	7	2961	FT817 Windom
Justin Pinnix	AJ4MJ	NC	20/40	< 5W	11	46	9	7	2898	IC746PRO G5RV
Mike Tindor	AA8IA	OH	20/40	< 5W	8	40	8	7	2240	FT950 80m doublet, parallel dipole
Jeff Hetherington	VA3JFF	ON	Hi Band	< 5W	9	42	7	7	2058	FT817 MQ-1 Hybrid Quad
Baltasar Diaz	EA8BVP		Hi Band	< 5W	7	33	7	7	1617	TS480SAT Inv L
Michael Blama	WA8SAN	OH	40	< 5W	7	34	6	7	1428	
Timothy Gordish	AD7AN	MT	40	< 5W	7	29	6	7	1218	Argonaut V SteppIR Vertical
Randy Jones	K8ZF	RI	20/40	< 1W	6	27	4	10	1080	IC703+ G5RV
José A. Gurutzarri	EA2IF		20	< 5W	6	29	5	7	1015	TS940SAT TH5-DX
Bert Cook	K6CSL	CA	ALL	< 250mW	4	15	3	15	675	
Gregg Mulder	WB8LZG	MI	20	< 5W	4	17	4	7	476	K2 Dipole
Don DiTullio	N1LU	TN	20/40	< 5W		17	4	7	476	IC746PRO 75ft random wire
Lou Visconti	KD2MU	NY	20/40	< 5W	6	13	5	7	455	K2
R.C. Hulett	KB5JO	TX	20	< 5W	4	20	3	7	420	Argo 509 EDZ
Rem O'Donnelley	K6BBQ	CA	20	< 5W	2	10	2	7	140	
Anton Vermaak	N9WAY	WI	20	< 5W	2	10	1	7	70	TS120V 40m OCF Dipole

Lots of good QSOs on 20, 40 and 80 Meters, but didn't hear anyone on 15 Meters. Nice to hear HA7UG, HB9DAX and G3RSP. Also EA2LU was very strong off the side of my beam. Missed N4BP on 20 Meters, usually my first contest QSO. **—AI2T**

What a difference a week makes. Propagation, particularly to western North America, was poor and the bands were very noisy. I had a few contacts with European stations on 15m but only one local contact on 10m. That band was totally closed here throughout the contest. **—VE3EUR**

Poor conditions on the high bands this time. Lots of QRM with the QCWA QSO Party. **—W5ESE**

I cud snivel abt poor band condx and line noise and lack of op time but still fun. **—K7NTW**

Great fun! Good conditions. Good friends. Nice WX. Who could ask for more? Thanks to ARCI for putting this on. **—WA4GIR**

Much Fun! **—KØNWT**

Just joined, what a great contest! **—KJ4AOM**

I got a late start and could not play as hard as I wanted to but I had a great time. I heard a lot of really good signals and great fists and they were hearing my 70 mW too. I tired 15 meters, but could not get a reply so I went back down to 20 and 40. I worked Spain and Hungary and logged what they sent for their exchange. **—AC8AP**

This was a grind. 42 QSOs in 6 hrs. Signals were quite weak and lots of dead air time on 20M. Couldn't spend much time on 40M. Either propagation was poor, or I missed all of the good openings! Thanks to all who were able to squeeze out

a QSO with me. See you in the fall! —**WA5RML**

I enjoyed it a very much. I've been pretty inactive the last couple of years, but I stumbled upon this listing in the contest correl. Thought I'd give it a try, and ended up renewing my membership which was expired. —**KG2H**

No propagation into Calif. KK6MC was very loud on all bands. Beat out N4BP for the first time. —**NK6A**

Very busy weekend, only go into the last hour. —**W4QO**

It was a cold and windy weekend and propagation left something to be desired. —**WF4I**

My first time entering —**VE7KBN**

Tried to setup portable outside during daylight hours but wind was quite strong. Band dropped out and shut down almost entire weekend. Still a good time either way. —**VE3FAL**

Didn't have much time for radios, but wanted to turn in a log anyways. —**WA8SAN**

It wouldn't be a formal entry without working N4BP —**K8ZF**

I was tied all weekend with family and couldn't participate. I'm sorry about that. —**EA2IF**

I only got to get on for the last 2 hours after arriving home from a 2 week trip to visit relatives in KS. It was nice to see 10M open and available to QRP. —**K6CSL**

I forgot about the sprint until the end, when I heard a "flurry" of CW activity at the 20m QRP watering hole. So I decided to join in for a mini sprint. —**WB8LZG**

/P in a field North of San Francisco. Rig FT-817, Ant—40mtr EFHWA. This was my first ARCI contest since becoming a member in January. I look forward to the next one but hope conditions are much better as there was a lot of QRN and QSB when I was on. —**K6BBQ** ●●

Contest Announcements

2011 QRP-ARCI Fall QSO Party

Date/Time:
1200Z on 15 October 2011 through 2400Z on 16 October 2011. You may work a maximum of 24 hours of the 36 hour period.

Mode:
HF CW only.

Exchange:
Members send: RST, State/Province/Country, ARCI member number
Non-Members send: RST, State/Province/Country, Power Out

QSO Points:
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:
SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:
>5 Watts = x1
>1 - 5 Watts = x7
>250 mW - 1 Watt = x10
>55 mW - 250 mW = x15
55 mW or less = x20

Suggested Frequencies:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (listen at 7040 kHz for rock bound participants)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:
Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier.

Mulitoperator:
A multioperator effort may submit logs for a separate category. Any combination of operators and transmitters will be permitted. All transmitters must be located at a centralized location. All operators must use the same callsign in the multioperator category.

Teams:
You may enter as a team with an unlimited number of operators as long as no more than 5 transmitters are on the air concurrently. You compete individually as well as on the team. Teams need not be in the same location. Team captains must send a list of members to the Contest Manager before the contest.

Categories:
Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m)

How to Participate:
Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Deadline:
Entries must be postmarked on or before 30 October 2011.

Results:
Will be published in *QRP Quarterly* and shown on the QRP-ARCI website, www.qrparci.org.

Certificates:
Will be awarded to the top scoring entrant in each category. Certificates may be awarded for 2nd and 3rd place if entries are sufficient in a category.

2011 QRP-ARCI Top Band Sprint

Date/Time:
0000Z to 0600Z on 1 December 2011
(Note, this is the evening of 30 November 2011 in North America)

Mode:
SSB, CW or mixed modes. Work stations once regardless of mode.

Exchange:
Members send: RS(T), State/Province/Country, ARCI member number
Non-Members send: RS(T), State/Province/Country, Power Out

QSO Points:
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:
SPC (State/Province/Country) total for all bands.

Power Multiplier: (Use the smaller multiplier if operating mixed mode)

For SSB QSOs:
>10 Watts = x1
>2 - 10 Watts = x7
>500mW - 2 Watts = x10
>100mW - 500mW = x15
100mW or less = x20

For CW QSOs:
>5 Watts = x1
>1 - 5 Watts = x7
>250 mW - 1 Watt = x10
>55 mW - 250 mW = x15
55mW or less = x20

Suggested Frequencies:
CW: around 1810 kHz
SSB: around 1910 kHz
*Please remember that 1830 to 1835 kHz should be used for inter-continental QSO's only

Score:
Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier

Categories:
Entry may be SSB, CW or Mixed Mode

How to Participate:
Get on top band and hang out near the QRP frequencies listed above. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Deadline:
Entries must be postmarked on or before 15 December 2011.

Results:
Will be published in *QRP Quarterly* and shown on the QRP-ARCI website, www.qrparci.org.

Certificates:
Will be awarded to the top scoring entrant in each category. Certificates may be awarded for 2nd and 3rd place if entries are sufficient in a category.

2011 QRP-ARCI Holiday Spirits Homebrew Sprint

Date/Time:
2000Z to 2359Z on 18 December 2011

Mode:
HF CW Only.

Exchange:
Members send: RST, State/Province/Country, ARCI member number
Non-Members send: RST, State/Province/Country, Power Out

QSO Points:
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:
SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:
>5 Watts = x1
>1 - 5 Watts = x7
>250 mW - 1 Watt = x10
>55 mW - 250 mW = x15
55 mW or less = x20

Suggested Frequencies:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (listen at 7040 kHz for rock bound participants)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:
Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier + Bonus Points.

Bonus Points:
If operating a HB Transmitter add 2000 points per band
If operating a HB Receiver add 3000 points per band
If operating a HB Transceiver add 5000 points per band
(Homebrew is defined as: if you built it, it is homebrew (kits too!)

If you are operating PORTABLE using battery power AND a temporary antenna, add 5000 points to your final score. (You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

Categories:
Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m-160m)

How to Participate:
Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Deadline:
Entries must be postmarked on or before 2 January 2012.

Results:
Will be published in *QRP Quarterly* and shown on the QRP-ARCI website, www.qrparci.org.

Certificates:
Will be awarded to the top scoring entrant in each category, as well as the top scoring entrants from each State, Province and Country. Certificates may be awarded for 2nd and 3rd place if entries are sufficient in a category.

For all Contests — Log Submission and Publication of Results

Email Submission—Submit Logs in plain text format along with a summary stating your Callsign, Entry Category, Actual Power and Station Description along with score calculation to contest@qrparci.org

Snail mail Submission—Submit Logs along with a summary stating your Callsign, Entry Category, Actual Power and Station Description, along with score calculation to:

QRP-ARCI (Name of Contest)
c/o Jeff Hetherington, VA3JFF
139 Elizabeth St. W.
Welland, Ontario
Canada L3C 4M3

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Will be published in *QRP Quarterly* and shown on the QRP-ARCI website, www.qrparci.org

A Pocket Sized 20M QRP SSB Transceiver

Pete Juliano—N6QW radioguy90@hotmail.com

In a June 1963 *QST* article, Ben Vester, W3TLN described a homebrew 20M SSB transceiver which measured 5 x 7 x 2 inches and had a power output of 250 mW. It was virtually dwarfed by the famous D-104 lollipop microphone sitting nearby. At that time, his radio was leading edge technology and true QRPp! Operating at 6 VDC, it was to be used mobile in his Volkswagen Beetle. [Pre-1966, all Beetles were 6 volt.] Some of you may remember that the Beetles were pretty small cars, especially for their day, so space was probably at a premium which caused Vester's quest for a small mobile rig. The architecture of Vester's radio had a four-pole homebrew filter crystal filter at 8.55 MHz and a VXO operating at 22.9 MHz, which results in a signal at the high end of 20 Meters! Portions of the circuit were bilateral, used both for transmitting and receiving, and the switchover to transmit was done with mechanical switches.

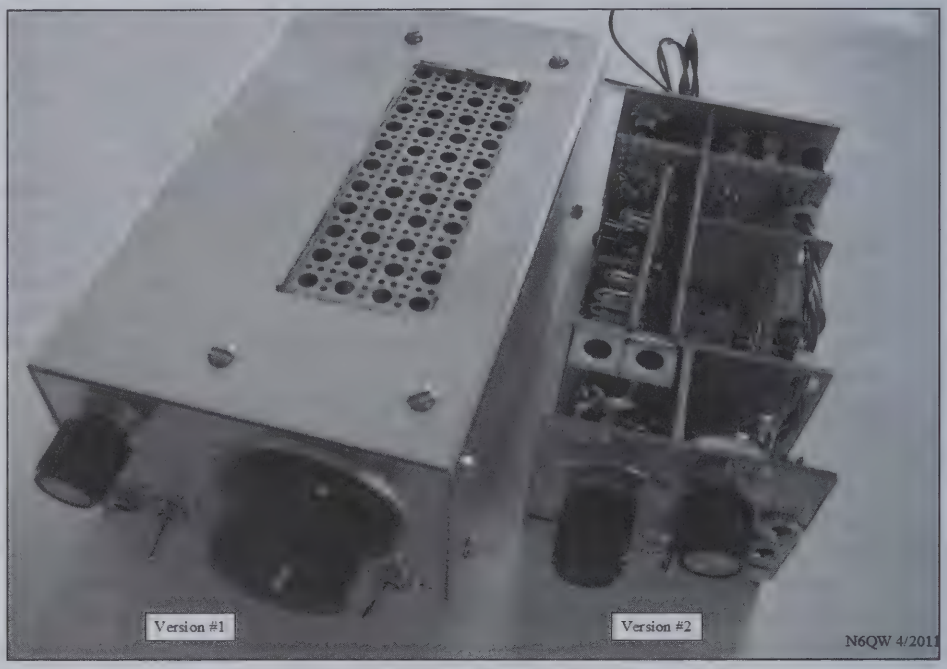

Figure 1—Size comparison of the two transceiver versions.

Following that lead of some 48 years ago, this article describes the construction of a shirt pocket sized 20M QRP SSB Transceiver. The radio described in this article is the second generation of a radio built earlier in 2011. The first version was 2 x 3 x 5 inches, so you would need a large shirt pocket. The second version weighs in at 2 x 4 x 2 inches and is the result of seeing a project by Allison Parent, KB1GMX, who built a really small SSB transceiver for use on six meters. I simply followed how she physically constructed her radio and made a remarkable volume reduction of nearly 50% compared to the first version of my transceiver. The key to her design was the use of double-sided copper PC board that was arranged in small compartments to create a skeletal framework. Her approach adds greatly to circuit isolation and stability. Figure 1 is a photo of the completed radio sitting beside the original version (V1). If you search You Tube for N6QW, there are several videos which show the various stages of construction for both versions.

In shrinking down the size of the radio, I already knew it was a proven design and had the first version as a benchmark. With Version 2, the challenge was to shrink down the size and not necessarily prove that the design worked. That said, let me not mislead you. Making the physical construction much smaller, in itself created problems with interconnectivity, control wiring routing and heat transfer. One cannot approach Version 2 in a casual manner and expect everything to work from the get go. KB1GMX provided much insight into considering all of these factors and was most helpful with technical information. Thank you, Allison!

Sufficient information is provided here to replicate this project. Schematics are provided in this article as well as available for download from my website, www.jessystems.com. However, I primarily want to focus here on some of the design decisions that were made to shrink the radio down to its current size. In general, I was able to preserve almost all the features in Version 2 that were in Version 1. However given that Version 2 is a good bit

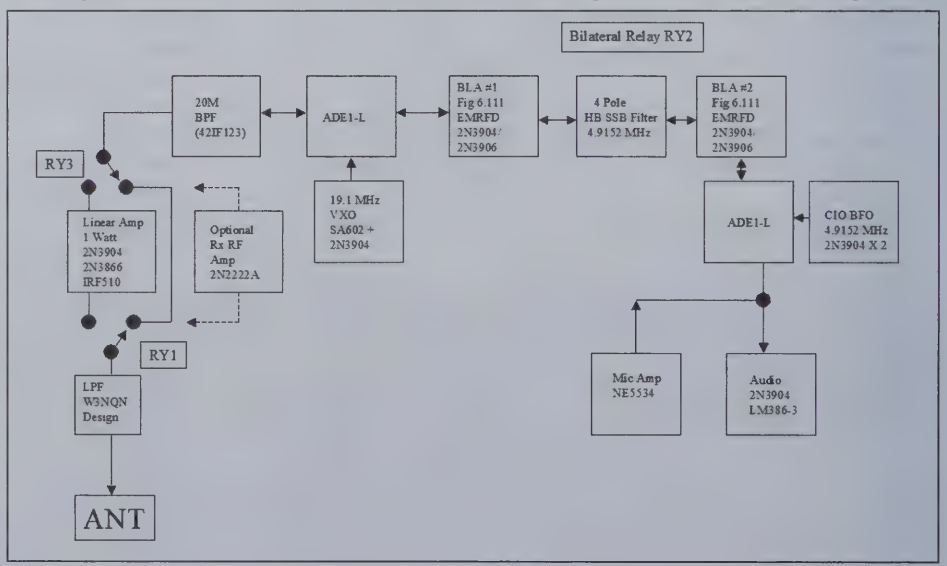

Figure 2—Transceiver block diagram.

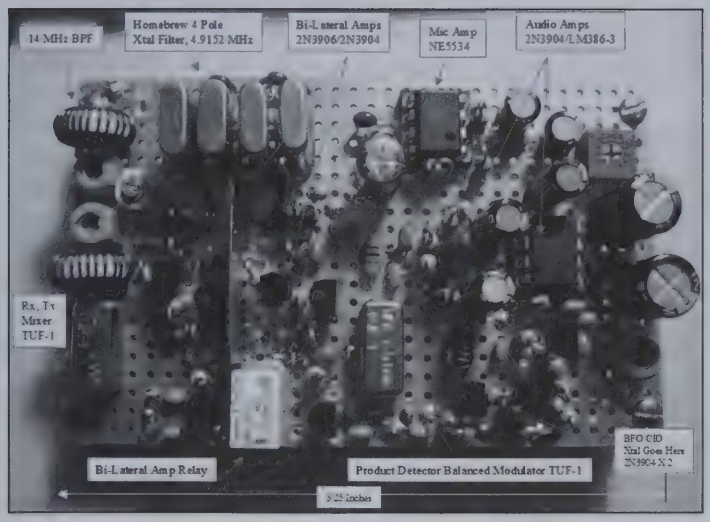
14 MHz BPF
Homebrew 4 Pole Xtal Filter, 4.9152 MHz
Bi-Lateral Amps 2N3906/2N3904
Mic Amp NE5534
Audio Amps 2N3904/LM386-3
Rx, Tx Mixer TUF-1
BFO CIO Xtal Goes Here 2N3904 X2
Bi-Lateral Amp Relay
Product Detector Balanced Modulator TUF-1
3.25 Inches

Figure 3—Main board photo of Version #1.

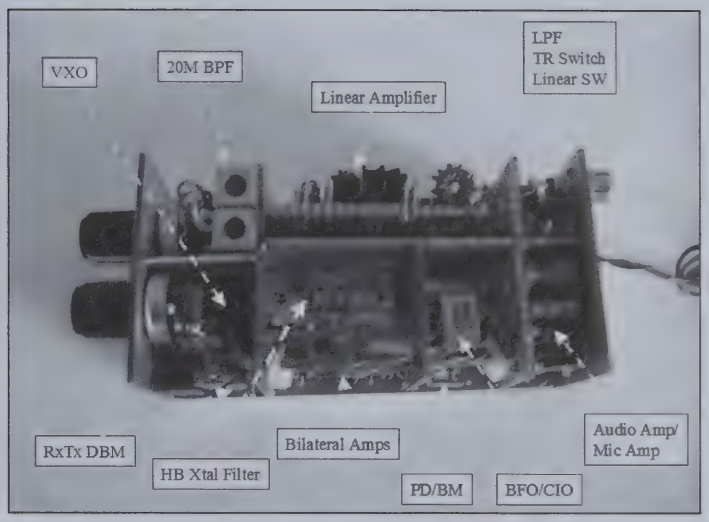

Figure 4—Plan view photo of Version #2.

smaller, I had to make some concessions on power output. Version 2 is limited to one watt while Version 1 can do over 2 watts. Fortunately, both have the capability to switch on a ten watt external "after burner" which I will also discuss here. Running V2 with the external amplifier at 10 watts PEP, I have had about 6 DX contacts in the first few days of operation. I have also had two 1 watt QSOs. Not bad for something that fits in the palm of your hand. Signal reports have all been excellent and frequency stability is superb owing to the VXO. Version 1 also had a receiver RF amplifier that is absent in the second version and not missed.

This radio evolved from some design specifications of my own. The radio had to be small, ideally something that would fit in a shirt pocket but more realistically something that could fit in the palm of your hand. The output power needed to be at least one watt in order to drive an external amplifier and the tuning had to cover more than just a few kilohertz. The audio stage should have enough "umpf" to drive an external loud speaker. It had to have a stable output with enough sensitivity to actually hear DX stations on 20M. It would not involve a PC Board. Bilateral circuits would be employed so that the part count would be reduced and there would be no AGC circuit in order to save space. It would be a SSB only radio. The IF frequency would be 4.9152 MHz. (Later you will see why this was a really good choice.) Standard transistors and IC's would be employed so that parts procurement would not be a problem. As it turns out, all required parts can be purchased from Mouser or Digikey with three exceptions. The ADE-1L double balanced mixers can be obtained from Mini-Circuits Labs, ferrite and iron powder cores came from Amidon and some inexpensive (about $1 a piece) ultra-miniature 5 VDC DPDT relays came from All Electronics to make it all possible.

Let us start with Figure 2, which is the block diagram. There is not too much unusual about my approach nor are there any exotic parts. Several SMD parts were used to take advantage of their smaller foot print and these include the double balanced mixers (ADE-1L), the VXO that uses the venerable SA602 in an SOIC8 version and finally a couple of size 1206 10 nF bypass caps. Basically it is a bilateral transceiver where many circuits are being used for both transmit and receive and this same approach has been successfully employed in many of the transceivers I have built. To transition from receive to transmit merely involves changing the signal direction.

My main challenge in transitioning to Version 2 was to find out what made the most sense in arranging the circuit blocks. In Version 1, there were essentially four boards that make up the transceiver. The first was the main board that contained all of the blocks from the band pass filter to the audio amplifier and microphone amplifier. Figure 3 shows the main board as it was built for Version 1. The second board was the switched crystal heterodyne VXO. The third board was the Tx and Rx RF amplifier board and finally the fourth board contained the TR switch and LPF. These circuits had to be made into smaller chunks so they could fit into the various nooks and crannies in Version 2. Much thought was given to space allocation, mounting options and board sizes. I soon realized in both versions that the final size was largely driven by the input and output devices and the real estate required for these parts. Even 3.5 mm stereo audio connectors do take up a finite amount of panel space. Even if the radio were to be converted to all surface mount parts, the I/O would still be problematic. Also, I have not found a really good source for ultra-small pots such as are used for the varactor tuning in the VXO and volume level in the audio amplifier. In Version 1, I was able to use a coaxial type connector for power to the radio. In Version 2, there was no room for such a connector so there is a short "pigtail" for power wiring coming out of the back of the radio.

For Version 2, there are seven separate sub-assemblies consisting of: 1) the audio and microphone circuits, 2) the BFO/CIO board and double balanced mixer (DBM), 3) a bilateral amplifier board, 4) a crystal filter board, 5) a switched crystal VXO, the band pass filter and DBM, 6) the transmitter RF amplifier board and 7) the last board containing a control relay and the low pass filter stage and external linear switch. All of the boards with the exception of those housing the VXO and two DBM's use single-sided copper Vector board. The use of the Vector type board provides a built in ground plane and all point to point wiring is done on the underside of the board. Connections going to ground are soldered

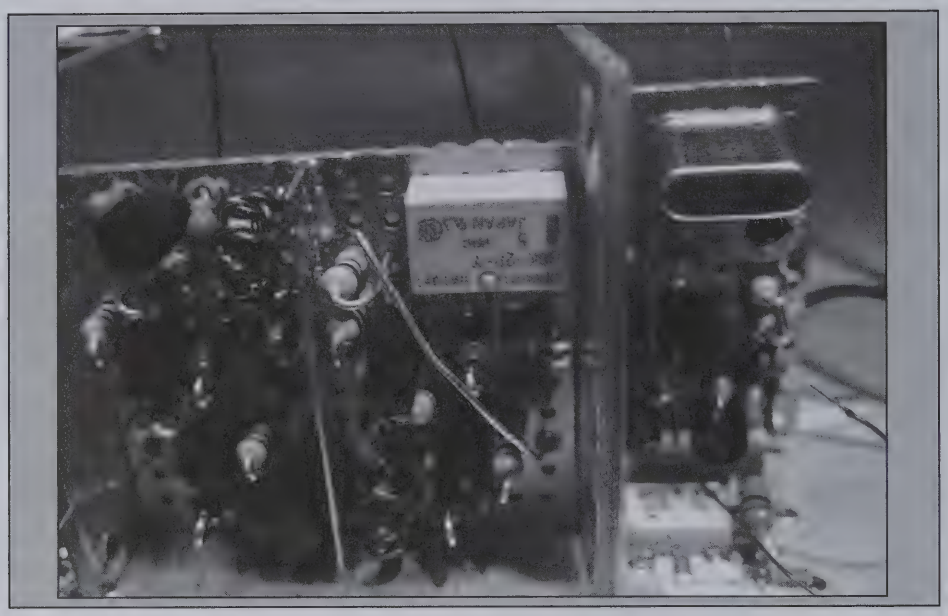

Figure 5—Bilateral amplifier and BFO photo.

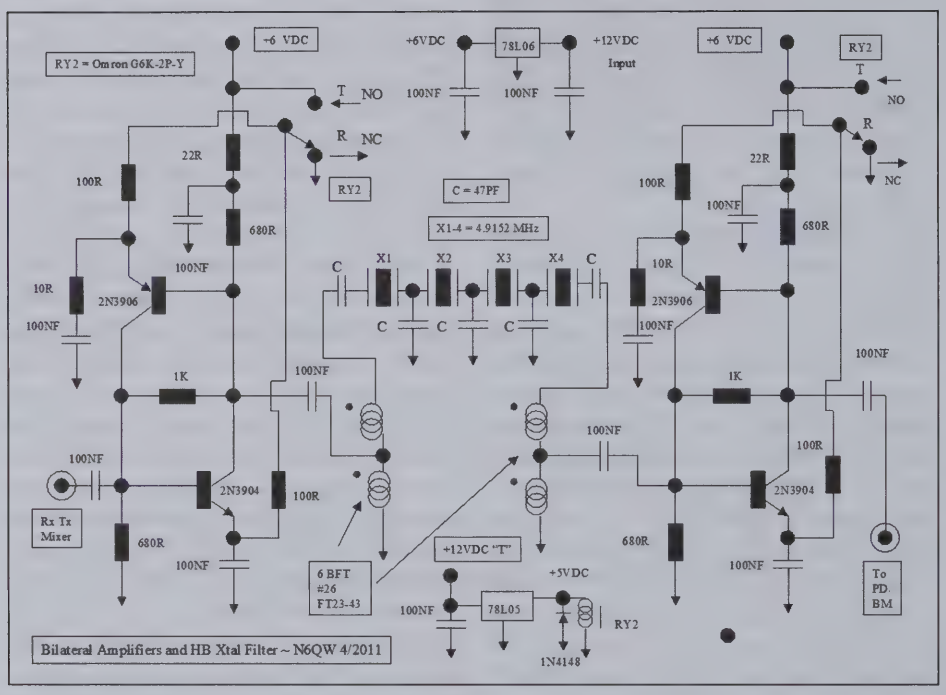

Figure 6—Schematic of bilateral amplifiers and crystal filter.

directly to the top of the board. Components that are connected to other components are passed through the board and connected to each other on the insulated side of the board. For components not connected to ground, I enlarge the top of each pass through hole with a couple of twists of a drill bit. This prevents shorts to ground. These individual assemblies are then soldered to a skeletal frame that is made entirely of double-sided PC Board. This affords a convenient total ground plane while providing isolated shielded compartments to discourage unwanted circuit interactions. Holes at convenient locations are used for passing control cables and power wiring. Figure 4 is a photo of the completed transceiver, which shows a plan view of how the circuit blocks were integrated into the final assembly. I should mention that it was actually possible to test most of the sub-assemblies before they were installed in the skeletal frame. This is absolutely mandatory, as once they are installed it is difficult to troubleshoot where there might be a bad component or shorted part. One of the crystal filter-matching transformers had a nicked wire and I found that it was shorting to ground. It would have been very difficult to find once it was installed. The base underneath the PC board that supports the PCB skeletal frame is a small piece of aluminum stock that will enable placing a "U" shaped cover over the entire assembly to form a box enclosure.

The final configuration has the switched crystal heterodyne VXO, the band pass filters (BPF) and the Rx-Tx DBM sitting directly behind the front panel. This facilitates short leads to the tuning potentiometer and allows the heterodyne crystals to be directly soldered to the panel mounted SPDT switch. This also enabled having the BPF a short distance from the Rx-Tx DBM and the shortest distance from the output of the VXO to the input of the DBM. In looking at the transceiver straight on, the bilateral amps, crystal filter, BFO/CIO and the audio and microphone amplifiers are installed along the right hand side of the assembly with appropriate shielding of the bilateral amplifiers and crystal filters from the BFO/CIO. Wiring for the audio and microphone circuits are in a twisted pair cable bundle, which runs along the top side of the right hand assemblies through a series of holes in the shielded assemblies. These terminate in the panel-mounted jacks and the volume control on the front panel. Along the left side, is the transmitter linear amplifier stage. The location of the band pass filter enables a short connection to this board and the ultra-miniature DPDT relay located on the transmit board. In the NC (normally closed) state, the Transmit stages are bypassed and a short length of ultra-miniature coaxial cable connects the low pass filter (LPF) to the band pass filter. On transmit, the linear amplifier stage is connected between the LPF and BPF. The final board mounted near the real panel houses the TR relay, LPF and the transistor switch used for keying an external linear amplifier. The antenna and linear amp switching connectors are the standard RCA type connectors. Much thought went into this configuration, much of it driven by what Allison, KB1GMX shared with me.

The bilateral amplifiers are a straight

lift from Figure 6.111 in *EMRFD* and a small ultra-miniature board mounted relay controls the signal direction. A modification suggested by KB1GMX was incorporated in the V2 build. She suggested adding two 10-ohm resistors to reduce the gain on transmit, as the level going into the Rx-Tx DBM would be quite high. Undoubtedly there will be the purists who will opine that the more elaborate form of the bilateral amplifiers should have been used, citing the need for constant impedance characteristics over a wide range of frequencies. Get a grip, as this is not intended to be a laboratory grade transceiver. The simple bilateral form works quite well and does a good job! Just watch the You Tube videos and you too will be amazed at how the venerable 2N3904/2N3906 combination works so well. That said, attention was paid to holding 50 ohm interfaces and two small matching transformers were constructed using FT-23-43 cores to match the 50 ohm in/out of the bilateral amplifiers to the approximately 200 ohm impedance of the crystal filter. On the other ends, the bilateral amplifiers interface with the ADE-1Ls which of course are 50-ohm.

Before I actually built the bilateral amps, I took a 4 x 6 inch piece of plain vector board stock and using a fixture I have, elevated the board so I could pass components through the holes. I initially masked off an area approximating the bilateral circuit board where I could place parts on the board to follow the circuit with an eye toward eliminating any crossovers and minimizing real estate usage. This worked very well. Figure 5 is a photo of the bilateral amplifiers and the BFO/CIO as the boards were being installed.

Figure 6, is the schematic for the bilateral amplifiers and the homebrew crystal filter. Crystals for the filter were selected from a larger stock of 4.9152 MHz crystals. Specifically, the crystals selected should be the four crystals whose resonant frequency is in closest proximity to each other. In no event should the crystals have more than a 50 to 100 Hz frequency spread. Typically a batch of ten to twelve crystals will be sufficient to find four crystals meeting the frequency spread requirement. Note also that the BFO/CIO crystal, also at 4.159 MHz, may require replacement in order to match the filter slope point. You will find out if your choice was

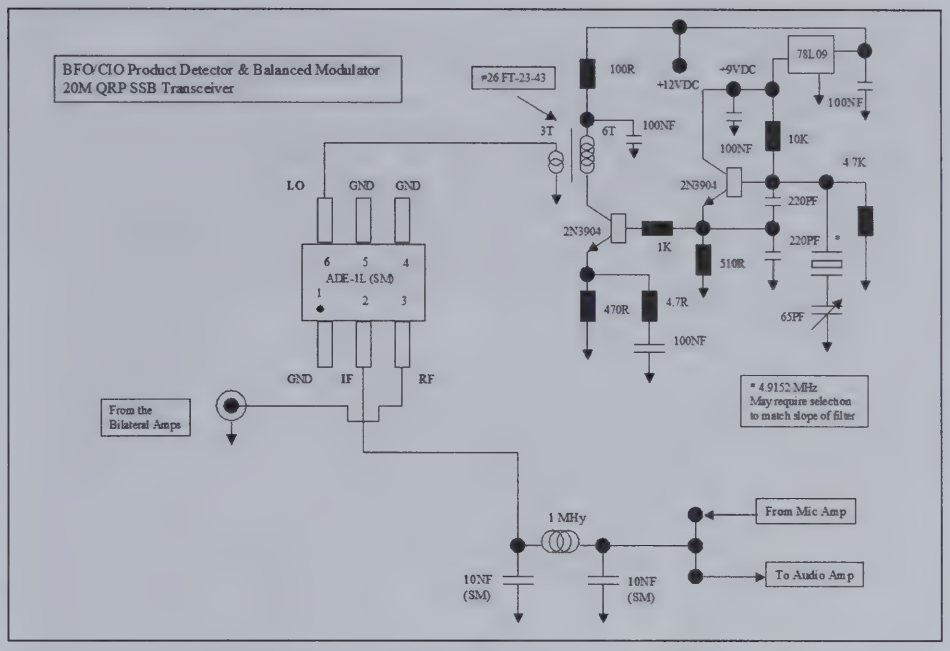

Figure 7—BFO/CIO product detector and balanced modulator schematic.

correct when you do the final tuning procedures. For this reason, the BFO/CIO crystal was placed at the top of the board so that it could be easily replaced.

Figure 7 is the schematic for the BFO/CIO, the product detector and balanced modulator. The product detector/balanced modulator is an ADE-1L. Note that this is a +3 dBm device, which means it needs less than 1 volt peak-to-peak of LO for optimum operation. The actual value needs to be 0.9 volts p-p. If you were to use another DBM such as the TUF-1 or SBL-1 then you would need about 1.414 volts p-p. In another N6QW transceiver featured in the Spring 2011 Edition of *QQ*, I included a small variable gain amplifier to assure +7 dBM is fed to an SBL-1. ADE-1Ls can be purchased directly from Mini-Circuits. A quantity buy dramatically drops the individual price of these units.

The choice of LO frequency was governed by the use of a Cohn crystal filter in the transceiver and by the availability of stock computer crystals used in the VXO. The asymmetric shape of the Cohn filter favors the generation of LSB and of course USB is the convention for 20M. The way to achieve USB with an LSB filter is to place the LO above the IF which in this case is 4.9152 MHz, e.g., 19.1 MHz - 4.9152 LSB = 14.184 MHz USB. This IF was chosen, by the way, because I have had excellent luck in the past with finding stock computer crystals that could heterodyne this frequency into suitable portions of the amateur bands. For example, you might want to look at the 17M QRP SSB transceiver on my website which uses 11.52 MHz computer crystals in a doubled super VXO configuration. In the present case, we need to generate an LO frequency in the range of 19.2652 MHz to 19.0652 in order to cover the SSB portion of the 20M band. Of course, covering the above entire range would be a tall order for a VXO. But, now I knew which crystals to look for in order to cover a usable fraction of the 20M band.

So, I spent some "quality time" with the online catalogs looking at the standard frequency computer crystals available. I found some 12.96 MHz crystals and some crystals in the low 6 MHz range which would heterodyne into the desired LO range. Based on my experience with the 17M transceiver mentioned above, I expected to achieve a usable frequency range using the 12.96 MHz crystals in a super VXO configuration. Some experimentation showed that three such crystals provided a 30+ kHz shift in frequency. Of course, the shift was to lower frequencies as is the usual case for a super VXO. By switching 6 MHz crystals, similar to the scheme I used in the 17M transceiver, I could achieve even more range. In the end, I found crystals at 6.144 MHz and 6.176 MHz. There was a third usable crystal at 6.25 MHz but it proved not to be available in small quantities at a reasonable cost. So my two 6 MHz crystals translated to a fre-

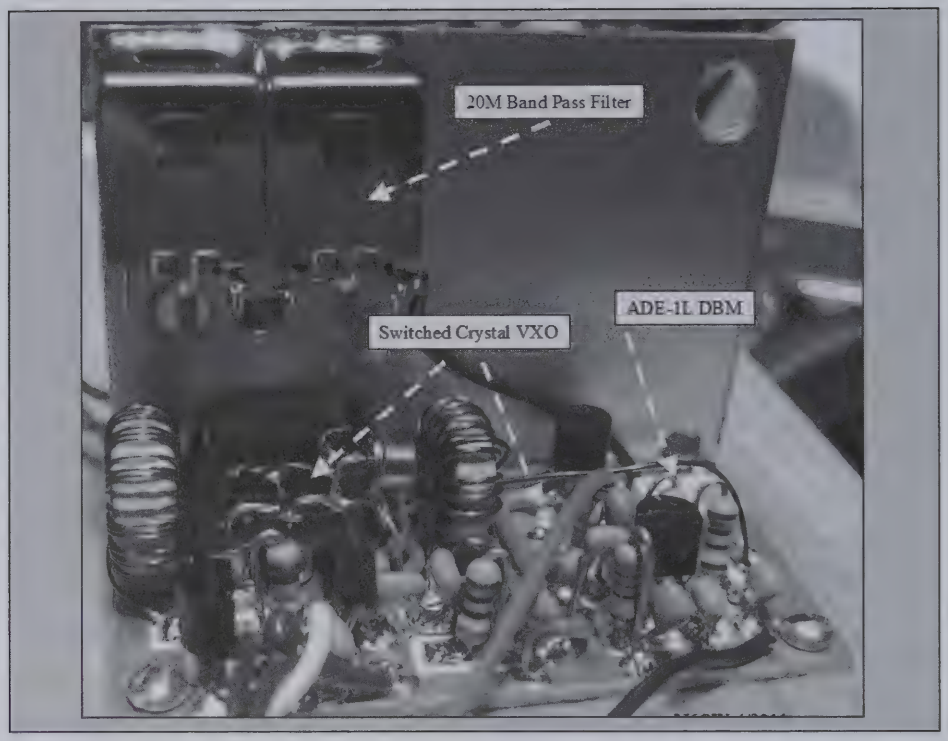

Figure 8—VXO photo.

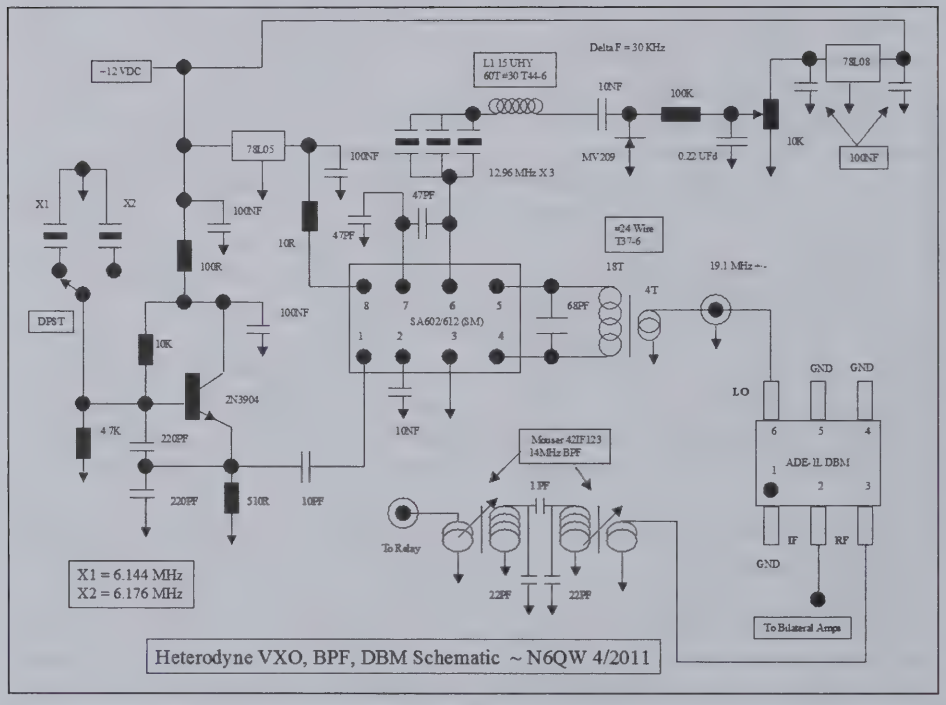

Figure 9—Schematic of VXO, band pass filter and RxTx mixer.

quency range of 14.160 MHz to 14.220 MHz, a very useful portion of the 20M band.

The implementation of my VXO is shown in Figure 8 and the schematic is in Figure 9. The horizontal board is about 2 inches by 1 inch and the vertical board containing the band pass filter is 1.75 inches high. The 6 MHz crystals (not shown) are attached directly to a front panel-mounted DPST switch. Some space was saved by using an SA602/612 as both the 12.96 MHz oscillator and mixer. VXO tuning is achieved using an MV209 varactor biased with a regulated 8.0 VDC supply. The change in capacitance is about 30 pF, which is a good tuning rate for a single-turn, panel-mounted potentiometer. The switched 6 MHz input is provided by a simple 2N3904 oscillator fed into pin 1 of the IC. A balanced output is taken across pins 4 and 5 which has a tuned network centered on 19.1 MHz.

The only remaining portion of the receiver is the audio amplifier, the schematic for which is shown in Figure 10. The microphone amplifier is shown in the same schematic, as the two stages are physically near each other. Figure 11 shows the parts placement for these two stages.

It is strongly recommended that the receiver be made operational at this point before proceeding on to the transmitter board. If the radio works flawlessly on receive then the transmitting function will work as designed. The VXO range should be calibrated and performance peaked. Proper operation of the VXO is by observation on an oscilloscope and measurement with a frequency counter. Alternatively, alignment and calibration can be done by tuning a general coverage receiver to 19.1 MHz and listening for the VXO signal.

Now we will shift to the transmitter RF amplifier board. Shown in Figure 12 is my second attempt at this board, which is about 1.75 inches high by 2 inches long. Figure 13 is the schematic for the Transmit Amplifier stage, which is straight out of EMRFD figures 2.93 and 2.98. It is run at one-watt output. On this board is another ultra-miniature relay which on receive connects to the receive side on the TR relay. Should a receiver RF amplifier (Figure 17) be added, it is a simple insert between the two relays.

A special note and caution about the IRF510. This device can be biased for more output but, given the small heatsink, STOP at 1 watt! The TO-220 heat sink is not enough and on the backside of the vector board is a slab of copper that is 1/8 inch thick and the same size as a TO-220 finned heatsink. This slab is in thermal contact with the IRF510 through a 6-32 by 1/2 inch long bolt which is attached to the IRF510 drain tab and passes through the regular heatsink, through the vector board and finally to the copper slab. I smoked the first IRF510 after a lengthy QSO as I exceeded the thermal ratings. I have often wondered why I have seen such very large

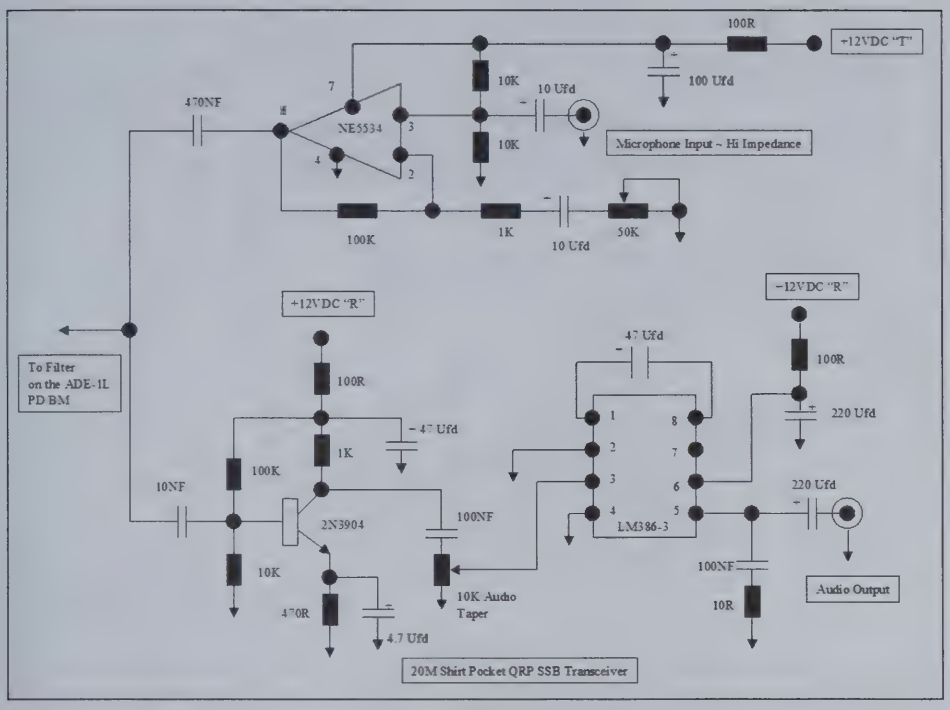

Figure 10—Audio and microphone amplifier schematics.

Figure 11—Audio and microphone amplifier photo.

heatsinks on MOSFET RF amps—now I know why! The IRF510 can safely pass 5.6 amps and a small clip-on TO-220 heat sink by itself is not enough. The final stage will do one watt safely but any more bias will cause the IRF510 to get so hot that it will finally fail! KB1GMX has used the entire skeletal frame as the heat sink for her project and this is where I should have taken advantage of her suggestion. She is using an entirely different RF amplifier chain but has purposefully held the output to 1 watt for the same thermal reasons.

Before installing the final amplifier board in its permanent position, it would be a wise idea to test the transmitter board and peak the circuits as necessary. Alignment of the transmitter board entails looking at the signals coming out of the various stages. I indicated earlier that it is wise to test the boards prior to final installation. I knew the microphone amplifier was working properly and simply probed the signal as it progressed through the transmitter stages looking at the output of

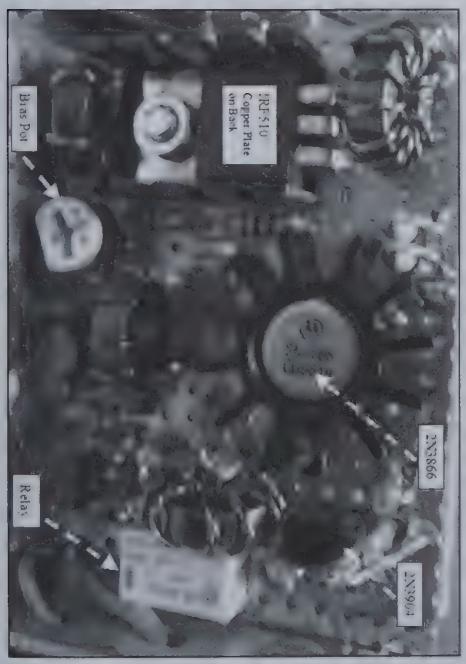

Figure 12—Photo of RF linear amplifier board.

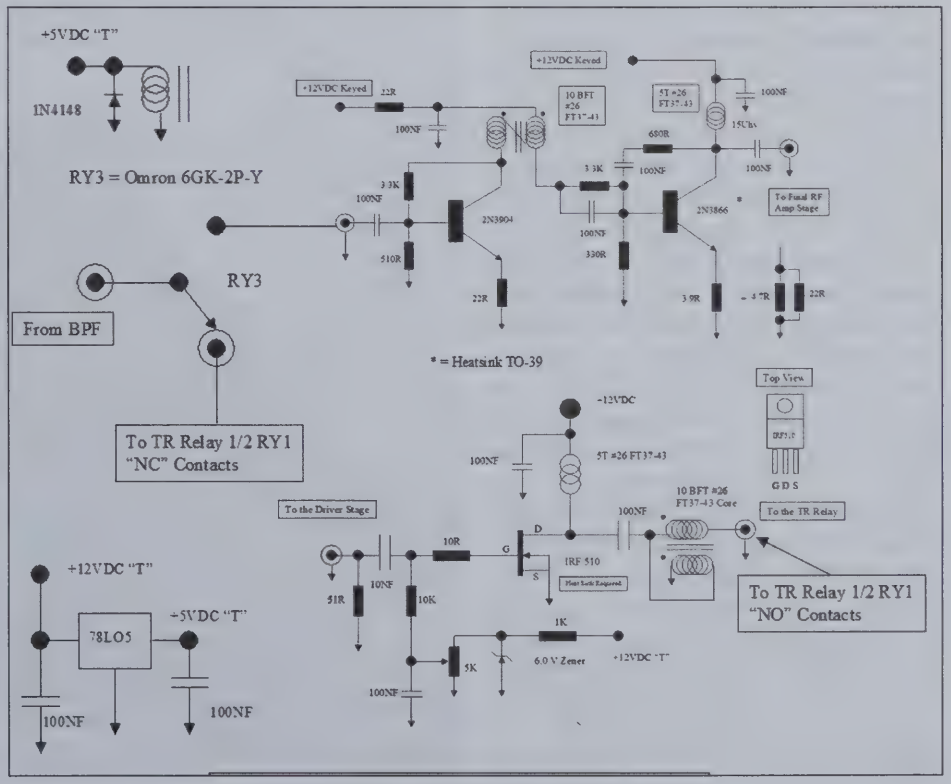

Figure 13—Schematic of the RF linear amplifier.

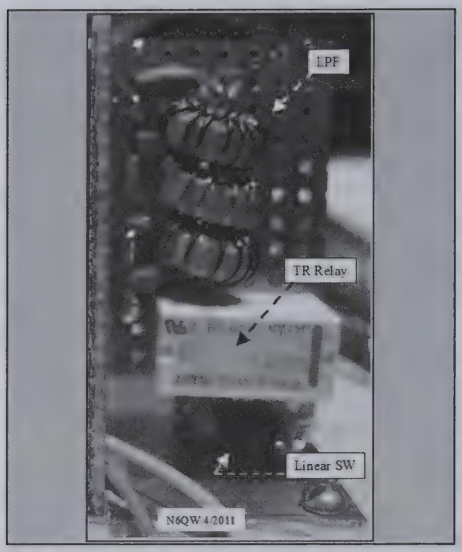

Figure 14—Photo of the TR switch, low pass filter and linear amplifier switch

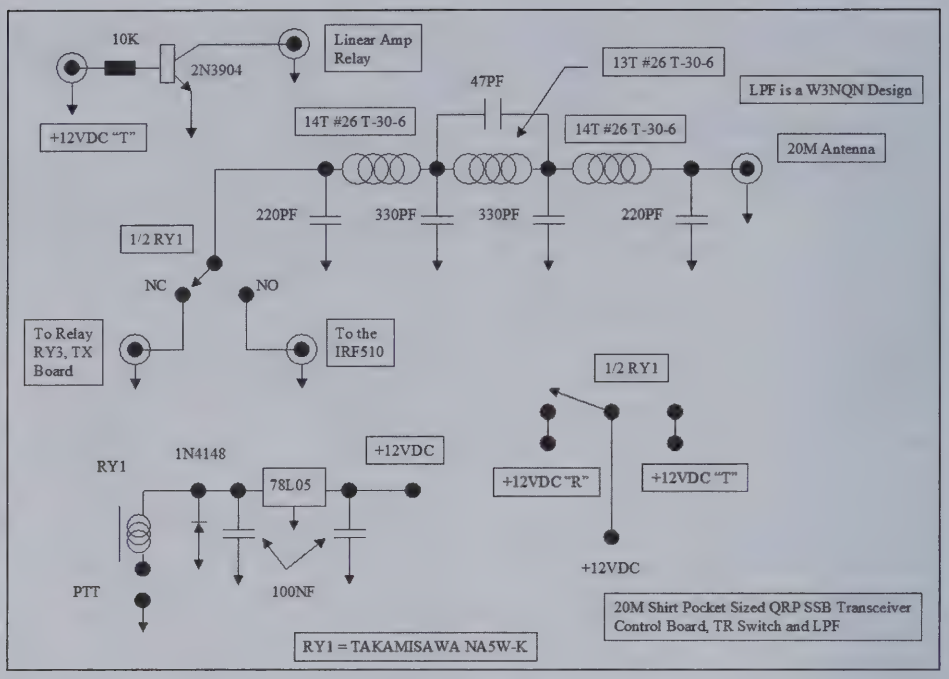

Figure 15—schematic of TR switch, low pass filter and linear amplifier control.

the balanced modulator, the bilateral amps and at the output of the band pass filter. I had the standard Christmas tree Pattern of about 50 mV p-p out of the BPF so I knew I was on track.

The last board is the TR relay and low pass filter (W3NQN design). The TR is a DPDT relay and one set of contacts provides DC voltage routing to bias on the various circuits in the receiver and transmitter. The PTT on the microphone jack controls this relay. The other half of the relay routes the antenna to either the transmit board or to the receiver input. The TR relay is permanently connected to the low pass filter. Figure 14 is a photo of this board and Figure 15 is the schematic. A simple 2N3904 is used as the DC switch for an external linear amplifier.

The band pass filter construction was greatly simplified by using an idea from Paul Daulton's article on the SESE 80 Meter receiver in the Winter 2011 issue of *QRP Quarterly*. In that article, Paul demonstrated how commercial 10.7 MHz IF transformers available from Mouser (P/N 42IF123) can be modified and used as a band pass filter on 20M. The modification entails removing the built in ceramic capacitor and replacing it with a 22 pF C0G capacitor. Pretty simple! These transformers are less than $1 and take up about the same amount of real estate as iron powder cores and trimmers. Being able to solder the IF cans to any copper surface is a real plus and gives much flexibility for mounting options. A big Thank You to Paul Daulton, K5WMS.

Tune-up entails the usual checks such as insuring the CIO/BFO is functioning. The final selection of the actual CIO/BFO crystal may take some cut-and-try to insure proper placement on the filter slope. A trimmer is provided for this purpose but it may take trying several crystals. The crystal was purposefully mounted at the top of this board to enable removal which I actually had to do.

Connecting an antenna directly to the band pass filter should net some on air signals. Here is where we apply TMS (Tune for Max Signal). 20M signals can be peaked by adjusting the cores on the band pass filters.

The one critical item in the tune-up is the setting of the bias potentiometer of the linear amplifier. Setting this potentiometer correctly insures that the output is linear and that the current drawn does not exceed

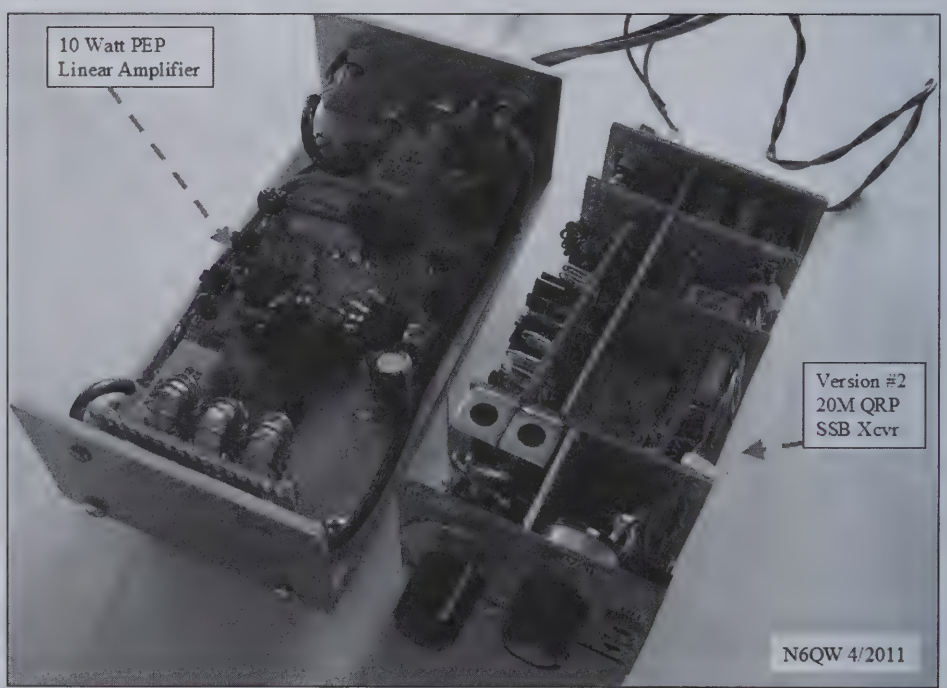

Figure 16—Photo of the 10 watt linear amplifier next to the radio.

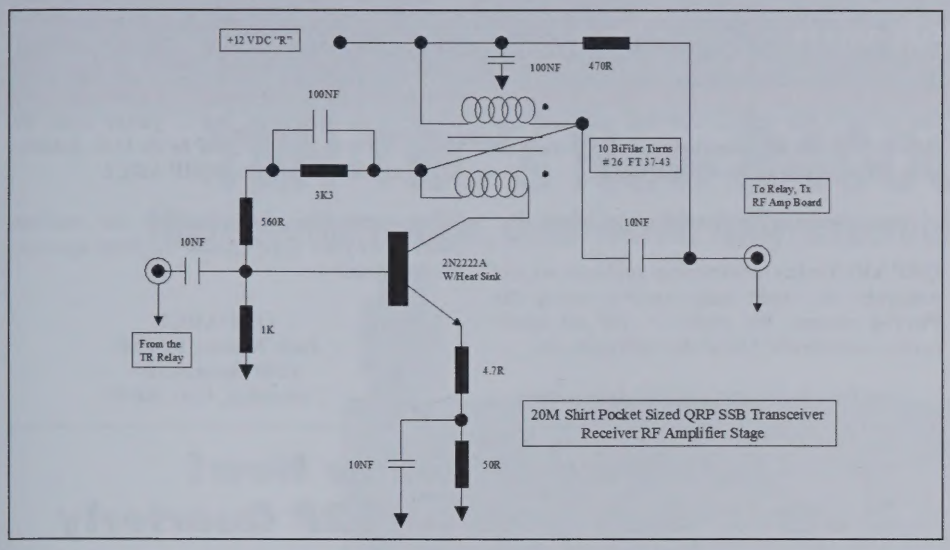

Figure 17—Schematic of the optional receiver RF amplifier.

the IRF510 rating. I started with the small bias pot about mid-scale and using an oscilloscope observed the output connected to a 50-ohm dummy load. Speaking into the microphone I noted when the peaks hit 20 volts p-p. That, my friend, is 1 watt rms.

At this point, you might want to try a few on-the-air QSO's and make sure everything is working. Once you are convinced of proper operation, you can do the final packaging at your leisure and consider building the separately packaged ten watt afterburner described here.

Following the V1 version, I completed a companion 10-watt MOSFET linear amplifier, very similar to the one found in *EMRFD*, Figure 2.101. Figure 18 shows the modified circuit as it appears in my unit. Circuit modifications include a relay bypass on receive, adding a low pass filter with circuit constants, and a slightly different bias network. The amplifier is operated on 12 volts DC. It is about the same size as the transceiver and I hope to actually test this in a mobile installation. I am almost ashamed to say that, especially when pioneers like Vester were doing 20M mobile with several hundred milliwatts. Operating with the 20M XCVR and this new amp from the home station, I have consistently worked across the US and even managed to snag a half dozen DX stations. Figure 16 is a photo of the 20M Shirt Pocket Size QRP SSB Transceiver and the companion 10-watt Linear Amplifier.

Hypothetically, you have now spent around $100 to build this radio and now you ask was the expenditure worth it? Well, I will give you my biased opinion: There is no greater joy than telling the station at the other end that you are running a homebrew pocket sized QRP SSB transceiver. The objectives stated early on have been met! QSO's have been made and the signal reports attest to the viability of the design and signal quality. However, you should realize that this is not a $700 radio—it does not have AGC and it only puts out one watt. It will not do CW, has a limited frequency range of roughly 60 kHz and will not mow the lawn nor take out the trash! But it is shirt pocket size and will give a good account of itself by providing many hours of fun and enjoyment.

AGC could be added if another form of bilateral amplifier was used like the one designed by Ron Taylor G4GXO and published in the GQRP *SPRAT #128*. A small board mounted relay could be used on receive to provide AGC control to the first bilateral amp using his design. In transmit, a fixed voltage is applied to this stage to set the gain. I built a dual conversion tri-band QRP SSB transceiver using this technique, which can be seen on my website www.jessystems.com.

Could this radio be made smaller? I would have to give a qualified "Yes," but that would now move the project to a circuit board. I have determined that the bilateral amps, the BFO/CIO, the audio amp stages and the VXO could be shifted to virtually all SMD parts. A different SMD op amp would need to be selected for the microphone amp but that does not seem like an obstacle. There are SMD parts that could be employed for the linear amp stage but that would require significant development work and be way beyond my skills. Could this radio be reduced by another 50%? Someone out there is already probably working on it! But the I/O and the available panel space still drive the final size!

—73/72, Pete, N6QW

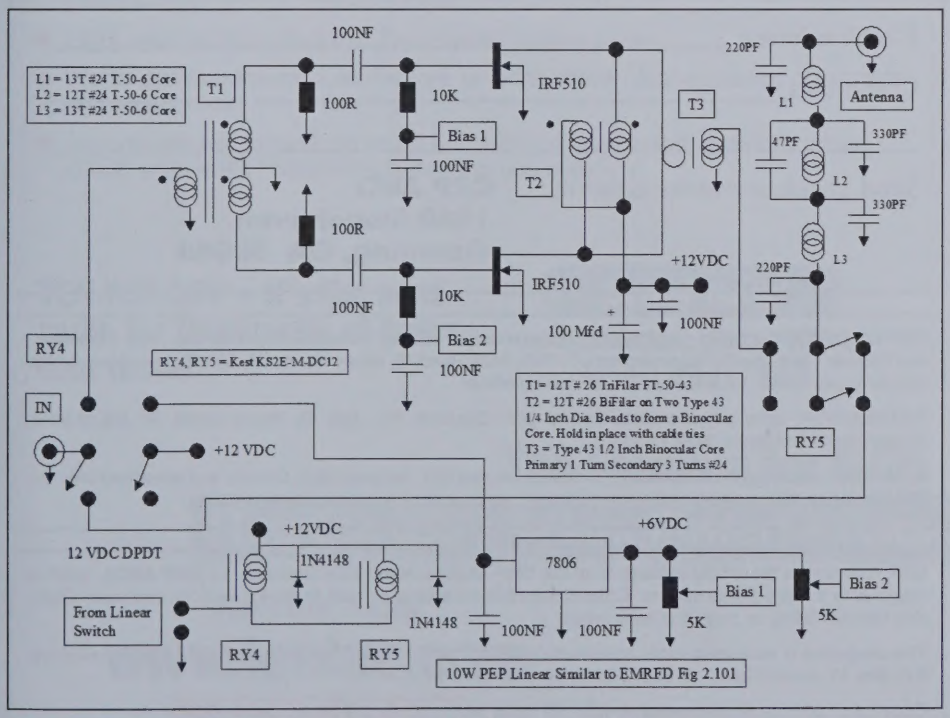

Figure 18—Schematic of the 10 watt PEP linear amplifier.

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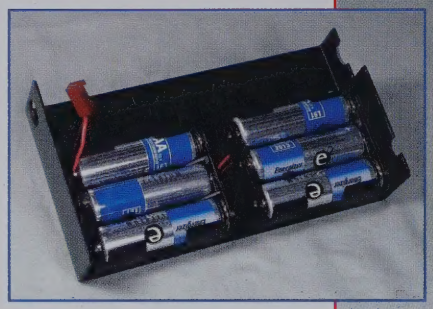

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